Lehigh

University Catalog – Courses for 1983-85

Academic
Alternatives
Aplenty

March, 1983

Lehigh

Contents

The illustrations: The covers and Section I, Special Academic Opportunities, feature photographs that show Lehigh students and faculty members in situations that illustrate a few of the many extraordinary educational resources of the university. Photographs by Theodore Anderson.

Front cover: Jeffrey Milet, head of the division of speech and theater, is a pioneer in the use of computer graphics to teach students how to visualize and even design theatrical sets with the help of computers. The terminal is located in the computer-aided design laboratory. Working with the professor is Brian L. Burkhart, who is majoring in mechanical engineering and taking theater courses.

Back cover: Lisa K. Schroeder, who is majoring in computer science, uses a reference volume in the reading room of Linerman Library. During 1983, the university planned to begin construction of an 80,000-square-foot, $10 million addition to its Mart Science and Engineering Library. The structure will represent the advance guard of sophisticated technology applied to information access.

Every effort has been made to insure accurate, consistent and complete information in this edition. However, the editors recognize their fallibility and refer the reader to a boast made by the editors of the 1771 edition of *Encyclopaedia Britannica*: "With regard to errors in general, either falling under the denomination of mental, typographical, or accidental, we are conscious of being able to point out a greater number than any critic whatever."

Volume 57, Number 1
March, 1983

George L. Beezer, editor
Joanne Anderson and
Michael Stoner, assistant editors
Marvin H. Simmons, associate director
Diane W. Hutchinson, Anne Reese, and
Penny Savakis, publications office staff assistants

Edited and produced by the office of university publications, Linderman 30, Lehigh University, Bethlehem, Pennsylvania 18015.

Lehigh (USPS 309-508) is published by Lehigh University four times per annum, in March, April, August, and November. Second-class postage paid at Bethlehem, Pennsylvania 18015.

About The Catalog

A university catalog serves many purposes and reaches many different audiences.

To a large extent, it is a reference book containing important information about the university. The course description section of this edition, for example, contains brief listings of and descriptions about the more than 2,000 course titles offered at Lehigh—the largest number of courses ever offered here. The section on advanced study and research describes some of the numerous possibilities for high-level research in a variety of disciplines. Other sections deal with the requirements of academic life.

Although some of this material seems esoteric, it all has a purpose for someone. Some of the people who use the catalog are prospective students who want to find out about the real intellectual and academic life of the university. Others are students who are already enrolled here; they need to select a specific course or find out about selecting an over-all course of study. Faculty advisers use catalogs to help undergraduates plan their academic careers.

Many of these uses seem mundane. It is true that a listing of course titles in itself is not exciting. But this catalog is actually a document with the potential to change the lives of students who use it well. In many ways it is a *key* to opening up the vast intellectual resources of the university to you.

The resources of Lehigh University exist in surprising variety considering the size of the institution. Although the university's relatively modest size means that it simply can't offer as many courses or opportunities as a larger institution, it can be more *flexible* and personal in its dealings with students, allowing those who are interested to design their own major programs and devise original plans of study tailored to their specific interests. The sense of intimacy even extends to the personal relationships some students develop with their professors.

Section I does not deal with the specifics of life at the university; rather, it suggests some of the educational opportunities available. If you read it carefully and use the rest of the book to guide you in setting up a course of study, you could benefit by developing a program that gives you what you want to learn. Select the appropriate courses. Be flexible and creative. Don't be afraid of subjects that seem to be challenging.

Well used, this catalog can open many doors to you, leading to new intellectual challenges as well as to insights about yourself and realizations about the nature of life—whether life is glimpsed in the words of a master poet, in an understanding of the workings of the genetic code, or in the substructure of an atom of silicon. By reading carefully, by following up on pertinent ideas and leads within these pages, by using the resources for learning that Lehigh offers, your limit to learning is yourself. (Which is not to say, though, that Lehigh offers *everything*!)

This catalog is intended to put the information about various opportunities for learning at Lehigh at your fingertips—but you need to know how to use it. A quick overview of what the catalog contains is in order.

Sections II and *VI* serve to introduce people to the university and community. If one understands something about the founding of Lehigh University and about Bethlehem, it is easier to see how both came to be what they are now. Many graduates of Lehigh have become highly successful in the business and professional world. Yet Lehigh was never intended to be just a technical institution. From its beginning, Asa Packer, the industrial magnate who founded Lehigh in 1865, intended education here to have a solid grounding in the liberal arts, which would complement technical education useful in an industrial world.

Asa Packer's ideal still guides education at Lehigh: It is the reason why there is emphasis on broadly based education, even in this era of increasing specialization in both technical and nontechnical areas of inquiry.

Section II also contains information that is pertinent to both prospective students as well as students already enrolled. It ranges in subject matter from costs to a list of the university's present and past presidents.

Section II tells you how to apply to Lehigh, and provides information about advanced placement and

financial aid, and a variety of other pertinent information.

Section III contains information about the various programs—majors and minors—available in the three colleges of the university—the College of Arts and Science, the College of Engineering and Physical Sciences, and the College of Business and Economics—that offer programs and courses of interest to undergraduates and graduate students. This deserves a careful reading; it suggests exciting possibilities that can enrich the academic experience.

Section IV contains information about opportunities for advanced course work and research offered by the three colleges, under the auspices of the Graduate School and the School of Education. While some undergraduates or prospective students may find little of direct interest in this section—few freshmen, for example, can imagine themselves taking graduate-level courses in solid-state materials or in literary criticism—the fact that advanced study represents a considerable effort at Lehigh is of importance to undergraduates. Some students *do* take graduate-level courses during their undergraduate years, and others plan on a future graduate degree while working toward the bachelor degree. Association with people in advanced study can bring personal and academic rewards to undergraduates and graduate students.

Section V contains a listing of courses taught at Lehigh, with a brief description of the material covered in the courses and the prerequisites, if any, that a student needs before taking the course. Students can survey the listings to get a sense of a department's offerings and interests. This is, by far, the most lengthy section of all.

Section VI gives a sense of place to the university. It tells about the historic commitment to education from the community's earliest days. Information also is given about the university's physical facilities and the people for whom some of them are named. Photographs of certain buildings are included. Newcomers or visitors will find university maps of the South Mountain academic and residential campus and the nearby Saucon Valley athletic complex. Directions to the university are provided.

Section VII contains a listing of the people associated with Lehigh University—its administration, its faculty, professional and paraprofessional staff, the people on its board of trustees, and the professors and outside experts who serve on visiting committees of the university—those who make suggestions about how departments and programs can improve their offerings and make their programs more relevant.

Section VIII consists of the academic calendar—what happens and when at Lehigh during calendar years that occur over the useful life of this edition. This calendar can be used by prospective students and those currently enrolled to plan their lives; many will want to make a photo copy of these pages and post them near their desks for easy reference.

Section IX is a comprehensive index to the contents of this edition. While no index can lead everyone conveniently to the information they may need, the effort has been made to expand the index so that most people can find page references for whatever data they seek.

The final page is a listing of major subjects, with page references. Keep in mind that Lehigh University is ever-changing in what it offers, especially so during a recent period, so that subjects may be added or the name of a program changed. Catalog users who do not find a subject they seek should make an inquiry with an appropriate university officer.

The above paragraph relates also to other content. The catalog is, in a sense a snapshot. It is intended to be accurate as of the day of publication. Because it has a useful life of perhaps two years, many changes can and do occur that cannot be recorded until the 1985 edition. Students on the campus are apprised of changes, and the viewbook that is sent to prospective undergraduates and special brochures sent to prospective graduate students routinely include new information as available.

Those who use the catalog who can suggest ways of improving the next edition are invited to send suggestions to the editors, who will refer the matter to the catalog committee of the university for consideration.

I

Special Academic Opportunities

Generally speaking, universities afford greater opportunities in breadth of studies than do colleges. Universities are by definition systems of colleges, so that they may have under one administrative umbrella a number of colleges, professional schools, and other entities in which students can do their studies.

Of course, the nation has some superb small colleges that do very well what they are intended to do. They probably should not aspire to become universities, lest they lose some of their accumulated lustre. Other colleges have grown large over a period of many decades or even in less time, and the title of university came about appropriately following that growth. (In Pennsylvania, Pennsylvania State University was originally Pennsylvania State College.) To the student interested or involved with Lehigh University, it may be of interest to know that Lehigh has been a university from the outset. There was never any "Lehigh College." Within the useful life of this catalog, Lehigh will have passed 120 years with university standing. Over this span of more than a century, the university has become mature, an institution of academic sophistication rivaling some of the oldest and best universities in the nation. In such a setting, excellent students are in good company.

Lehigh's colleges are as follows: College of Arts and Science, College of Business and Economics, and College of Engineering and Physical Sciences. All students take courses in more than the one college in which they are primarily enrolled. At the graduate level, Lehigh has the Graduate School, which encompasses some two dozen graduate programs across the university, and the School of Education, nearly all of whose offerings are at the graduate level, with many geared for professional educators and administrators.

Lehigh is far from an immense university, and the plan is to keep it of middle size. The level of personal contact among students, teachers, and administrators can be greater in a university of medium size, even with the breadth of study available. Interdisciplinary opportunities—where a student can study subjects that cross standard departmental lines—are plentiful at Lehigh.

The information that follows in this section is intended to give the reader some idea of the diversity of opportunity available to Lehigh students. The idea for such a section came about because in the past some students would arrive at Lehigh and be pleasantly surprised to find all that they could do academically. It seemed appropriate to at least summarize a few of the opportunities so that prospective students and those already enrolled could review the Lehigh potential in relation to their own interests and aspirations.

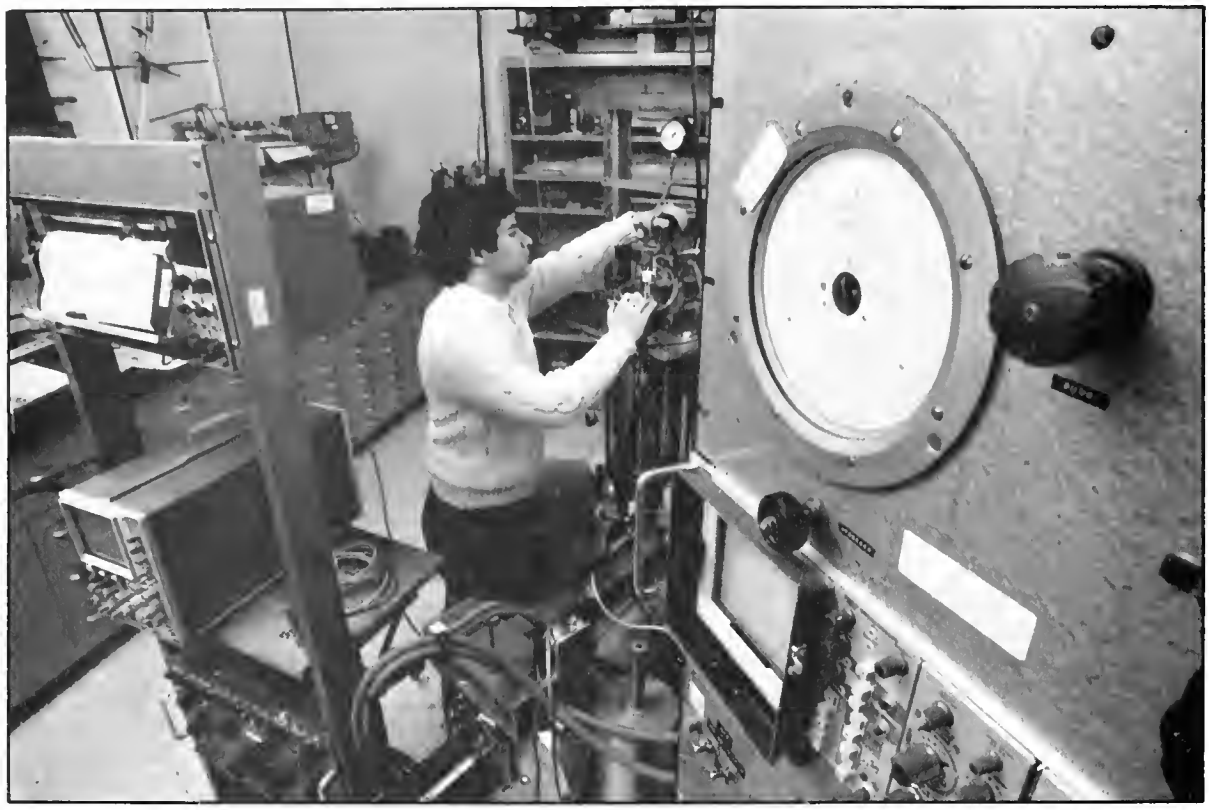
Major Programs

The university is organized into three colleges that offer undergraduate academic programs. These colleges offer the following programs leading to the bachelor of arts and bachelor of science degrees. (More specific information about requirements in each college is found in Section III.)

College of Arts and Science. The college offers the following major programs leading to the bachelor of arts degree: **American studies, architecture, art history, applied science (for Arts/Engineers), biology, chemistry, classics, classical civilization, economics, English, foreign careers, French, geology, German, government, history, international relations, journalism, journalism/science writing, mathematics, music, natural sciences, philosophy, physics, predental science, premedical science, psychology, religion studies, social relations, Spanish, studio art, theater,** and **urban studies.**

The college also offers major programs leading to the bachelor of science degree in: **biology, computing and information science, environmental science and resource management, geological sciences, geophysics,** and **statistics.**

There are a number of five-year programs available to undergraduates. For example, engineers can obtain a bachelor of arts degree in the College of Arts and Science and a bachelor of science degree in the College of Engineering and Physical Sciences, combining, for



In Sherman Fairchild Laboratory for Solid-State Studies, Bruce S. Itchkawitz is engaged in the "research participation" program available to seniors majoring in physics. The student, working in the laboratory of Wesley J. Van Sciver, professor of physics, makes an adjustment to a variable-temperature, liquid-helium cryostat in which a quartz crystal is mounted. He is studying luminescence in quartz, an aspect of solid-state optical spectroscopy.

example, journalism and physics.

There is also a special curriculum in which a student can obtain a B.A. and a master of business administration (M.B.A.) from the College of Business and Economics.

College of Business and Economics. Students in the college can obtain a bachelor of science degree in business with a major in **accounting, economics, finance, management,** or **marketing.**

College of Engineering and Physical Sciences. The college offers a number of majors leading to a bachelor of science degree. These are: **biochemistry, chemical engineering, chemistry, civil engineering, computer engineering, electrical engineering, engineering mechanics, engineering physics, fundamental sciences, industrial engineering, mechanical engineering, metallurgy and materials engineering.**

The college participates in the five-year arts-engineering curriculum in which a student can obtain a B.A. in the College of Arts and Science and a B.S. in an engineering field.

Minors. In addition to their studies in major subjects, students in all colleges may select related courses for a minor. There are a variety of interdisciplinary minors offered in the College of Arts and Science. For details, consult Section III.

Other options. These programs are more extensively described in Section V under the listings of the department that sponsors them. (See the major subject index on the back page for page references to specific programs.)

It should be evident in the above listings that some areas of study appear more than once. For example, a student can major in biology and obtain a B.A. or a B.S. Also, a student can major in chemistry in the College of Arts and Science and obtain a B.A., or obtain a B.S. in chemistry in the College of Engineering and Physical Science. Or a student can major in economics in the College of Arts and Science, obtaining a B.A., or major in economics in the College of Business and Economics for a B.S.

These options are offered for good reasons, depending on the interests and goals of the undergraduates who elect to take them. They differ mainly in the distribution of non-major courses required. By offering these choices, Lehigh makes it possible for students to obtain the broad background of a liberal arts major or the more specialized program of someone who pursues a bachelor of science degree.

Within each curriculum, students have choices of courses within categories of courses; students are also able to choose electives. Students can use these choices to achieve further specialization in their major subjects, or to broaden their field by taking courses in related, but separate, areas of study. They may choose to develop minors in an area of interest, either as declared minors or in a more unofficial approach. Courses from all colleges are available to all students at Lehigh who can meet course prerequisites as listed in the course descriptions.

Policy of Flexibility

There is considerable flexibility in undergraduate curricula at Lehigh, intended to take into consideration the changing interests and needs of students.

For example, in the College of Engineering and Physical Sciences, each department provides a range of credit hours needed for graduation; this provides flexibility to the student who wants to take more or less work outside the department. This flexibility extends to changes of major during the college career or even a change in college without loss of credits.

Graduate students may find their interests shifting to related fields as they progress in their educational program. They may wish to strengthen their preparation for a career by advanced study in a related field or in an interdisciplinary program. The policy of the Graduate School is to provide as much flexibility as possible to students who wish to change to a new but related field of

Three freshmen, all majoring in computer science, use computer remote terminals in Drown Hall, home of the College of Business and Economics. The students are (from left) Daniel A. Schwartz, Christopher D. Orr, and Karl R. Wurst. In addition to the university's main computing facilities, there are seven remote terminal sites across the campus, with a total of 120 terminals for student use.

study after either the baccalaureate (bachelor's degree) or the master's degree.

Students should consult with the director of their previous program and with the director of the new field in order to establish the course program that will remedy any deficiencies in background and will be of maximum value.

Students who have just completed a bachelor's degree in one field at Lehigh may find it advantageous to study for a graduate degree in a related field under a new group of faculty without losing the continuity and familiarity provided by staying on the Lehigh campus.

Independent Study

Juniors and seniors who want to study a subject that is not part of a regularly scheduled course, or who want to go into greater depth in a subject already studied, can schedule independent study. The independent study must be arranged with their major adviser and must have the approval of a department chairperson and the dean of the respective college.

Summer Opportunities

Learning need not be confined to the traditional academic year, nor to the traditional classroom or laboratory setting. The university offers a variety of summertime educational experiences. In addition to the normal educational opportunities offered to graduate and undergraduate students in summer sessions, there are also opportunities for remedial and accelerated work, as well as personal-interest study.

Special programs and field work activities are available for intense in-depth educational experiences. Examples of these include the Robert A. Taft Institute of Government, Field Study of Geology (conducted in Wyoming and Idaho), and the Civil Engineering Survey Field Course (conducted in the Pocono Mountains). Short courses and workshops are offered in many subject areas.

Interested students should consult with their curriculum director or the director of summer sessions. A publication listing the total summer program is available every spring.

Interdisciplinary Opportunities

While each college maintains a list of formally constituted, patterned majors, a variety of options are available to students with special interests or needs. Many opportunities cannot be listed in a catalog because they develop informally. Some are a direct benefit of Lehigh's modest size and university status.

All universities offer extensive graduate programs, unlike colleges, which do not. Thus, there are graduate course offerings and extensive research being carried out by the faculty, graduate students, postdoctoral students, and other professionals. Some graduate courses are available for advanced undergraduates, when appropriate. Even more important are opportunities that undergraduates have to participate in research. Some of these are noted below.

The faculty at Lehigh recognizes that even though the university's division into three colleges and various departments makes sense from a management standpoint, human learning and scholarly interests cannot be so easily categorized. Many people have interests that fall into a variety of fields. These interests can be addressed in a number of ways.

One example is the arts-engineering program already mentioned. A detailed description of the program can be found in Section V, but it offers a variety of options for the creative student. For example, a student who is interested in technical theater can take a B.A. in theater and a B.S. in mechanical engineering, working in the university's computer-aided design/computer-aided manufacturing (CAD-CAM) program to design mechanical systems for the theater.

Another student might combine a B.A. in journalism science writing with a B.S. in physics; or a B.A. in urban studies with a B.S. in civil engineering—perhaps a good

With some 370 faculty members, 95 percent of whom hold the Ph.D., the actual teaching process is obviously the primary function of the university. In this class, Stephen G. Buell, assistant professor in the department of management, finance, and marketing, College of Business and Economics, teaches about securities. The professor holds the B.S. in industrial engineering, the M.A. in economics, and the Ph.D. in finance.

preparation for someone interested in urban architecture and neighborhood development.

Students in the College of Arts and Science are exposed to a number of interdisciplinary majors—such as environmental sciences and resource management, and urban studies. With the aid of faculty members from several disciplines, they may work out their own major involving courses from two major subject areas of the college. A variety of interdisciplinary minors—Women's Studies, Jewish Studies, and Russian Studies, among others—are available in the college.

Research and the Student

Research is important at Lehigh, and each year the amount of time and resources devoted to research increases. The university has an outstanding reputation in several fields of research and some of its faculty members are internationally known in their fields.

The Lehigh research centers and institutes allow members of the faculty to concentrate their research efforts on projects of broad, interdisciplinary concern.

While it is often not easy for undergraduates to perceive the importance research has to them, there is a vital, direct link. Attending an institution at which research is given prominence allows undergraduates to use many facilities—such as laboratories and advanced scientific equipment—that would not be available at places where research did not play a major role. It means that the libraries at Lehigh have resources, subscribe to periodicals, and shelve books that institutions without active, ongoing research would not have. Undergraduates can use these resources for their own intellectual enrichment or pleasure.

But more importantly, because Lehigh supports its faculty members in pursuing their research interests, outstanding faculty are attracted to the university. Even though these people come because of their interest in research or teaching graduate students, they also participate in undergraduate education by teaching seminars, courses for advanced undergraduates, and even, occasionally, introductory courses.

What this means is that undergraduates encounter first-hand people who are involved in research and scholarly activity and who are making significant contributions to the advancement of knowledge. Undergraduates who take a laboratory with a distinguished engineer or a seminar with an eminent psychologist find that their professors communicate to their students the excitement of research and scholarly activity.

Being on a campus with an active research program also means that qualified undergraduates are able to participate in advanced courses, and even do research themselves, in ways that would not be possible at a larger institution. Because of Lehigh's relatively small size, such opportunities often occur through informal contacts with professors. One student, for example, walked into a laboratory in Sherman Fairchild Laboratory for Solid-State Studies and asked if there was anything he could do to help. He began cleaning up the laboratory and ended up designing and constructing laboratory equipment.

Research begun informally by students sometimes results in more than just practical research experience, important as that is. Some students have published the results of their research in scientific journals and one student designed an experiment that went aloft on missions of the NASA space shuttle.

Research initiates. While varied opportunities exist for students to become involved with research informally, there are also opportunities for qualified students to become research initiates in their junior and senior years.

Research initiates are attached to specific research projects in progress on the campus, serving as assistants to advanced graduate students or to staff members. They assist in experiments, sit in on project conferences and if occasion permits, undertake side investigations appropriate to their competence.

The research initiate may receive degree credit by registering for unrostered work for up to six hours per semester. In a few cases, a nominal stipend may be paid for the work, and summer employment is occasionally available. Students should explore the possibility of becoming a research initiate with the curriculum adviser.

Advanced Placement and Accelerated Programs

It is possible for students to accelerate their programs so that they may graduate in as little as three years. Such programs are made possible by credits awarded for advanced standing upon admission, credit by examination, overloads, and summer work. Interested students should consult with their curriculum advisers.

The university encourages the initiative that secondary school students are showing in enrolling in advanced courses, in requesting advanced standing, and in assuming responsibility for a greater share of their own education.

Besides opportunities for advanced placement of freshmen, sophomores are invited to consider the advantages of enrolling in some junior courses. This may be accomplished by special examinations available in certain courses for students who performed particularly well as freshmen.

In the junior year, students may register for interdepartmental honors seminars and in some programs may take "unscheduled work," where they have an opportunity to do individual work in consultation with a

member of the faculty. In the senior year students may continue with the interdepartmental honors seminars and may undertake departmental honors programs. Particularly well-qualified students are permitted to take a limited number of graduate courses. Some students engage in research projects in connection with their senior thesis.

The opportunities for able and well-motivated students are increasing each year and more students are qualifying for advanced sections and courses and honors programs.

Apprentice Teaching

The apprentice teaching program is designed to benefit juniors or seniors who wish to learn about teaching under the guidance and supervision of an experienced teacher. The apprentice receives instruction and experience in many aspects of the teaching process while working with the master teacher in one of his or her courses. Master and apprentice teachers are responsible for submitting to the department chairperson's approval an outline of the activities in which the apprentice will participate.

Apprentices typically receive three semester hours of credit for regularly attending classes, doing a limited amount of lecturing or leading of discussions, assisting in making up and evaluating some written assignments, and being available for individual consultation with students.

Apprentice teachers should have an over-all cumulative grade point average (GPA) of 2.8 or better, or a cumulative GPA of 3.32 in the major field in which the apprentice teaching is done, and should previously have taken for credit the course in which they will apprentice—or its equivalent. A student may register for apprentice teaching only once each semester, and only twice during the college career, for a total of not more than six hours of credit. The student may register to be an apprentice teacher in a given course only once.

A graduate student who is not a paid teaching assistant may register for apprentice teaching, but the department decides whether the student may receive credit that will count toward fulfilling degree requirements. The apprentice is graded for work in the course by the master teacher.

Students who wish to do apprentice teaching in courses outside a regular department, such as Freshman Seminars, may do so with the approval of the director of the program. In provisional courses or courses cross-listed in several departments, the approval of the chairperson of the department in which the course is taught is required. In such cases, the student registers for the 300-level courses with the same heading as the course in which he or she is an apprentice (e.g., FS 300, Apprentice Teaching in FS 97C).

This program carries the following provisions: except with the college dean's approval, professors do not accept more than two apprentice teachers per semester; master teachers supervise all aspects of the apprentice's work; the duties of the apprentice teacher are restricted to those that will provide a learning experience for students taking the course; the duties of apprentice teachers are not to be confused with those performed by paid graduate teaching assistants; the master teacher reports on the apprentice teaching experience to the department chairperson and to the dean of the college.

Cooperative College Program

Students and other members of the university community belong to a larger community, many of whose educational, cultural, and social events and opportunities are available to all. Lehigh has joined with the other colleges in the Lehigh Valley—Allentown College of St. Francis de Sales, Cedar Crest College, Lafayette College, Moravian College, and Muhlenberg College—to establish the Lehigh Valley Association of Independent Colleges (LVAIC) to promote cooperation among member institutions.

The association encourages students to take appropriate courses at other member schools, and provides for the remission of tuition for faculty members schools, and provides for the remission of tuition for faculty members and their spouses who wish to take undergraduate courses at any member institution.

In the office of career planning and placement services, Louisa M. Boetius, who is majoring in accounting, confers with Marilyn Mackes, assistant director. Perusing printed materials at the table are (clockwise from top): Peter P. Perry, Jr., who is majoring in social psychology and psychology; Betsy Jean Barmat, who is majoring in marketing and art; Lisa Yvette Muscatello, an English major; and Flor Joanna Saltiel, an accounting major.

Lehigh students are eligible for admission to certain events held at other association colleges on the same terms as students from the host institution. Further, the association funds and administers joint academic degree programs, faculty exchange programs, special lectures and symposia, the interlibrary loan of texts, films and audio-visual equipment, and professional development workshops. Information is available from the registrar.

Five-Year, Two-Degree Programs

The university's five-year, two-degree programs enable a student to receive either two bachelor degrees or a bachelor and a master's degree upon completion of five years of study.

Most five-year, two-degree programs appear in Section V under Arts-Engineering, Civil Engineering and Geological Sciences, Electrical Engineering and Engineering Physics, and Engineering-Master of Business Administration. It is possible to arrange for a dual bachelor degree program even after being enrolled for some time. Engineering students, for example, who decide at any stage of study that they wish to meet the requirements for both the bachelor of arts and bachelor of science degree may complete the combined requirements in five or possibly six years, depending on when they decide to try for both degrees.

Students from all three undergraduate colleges take courses in the arts. Here, in a studio in Chandler-Ullmann Hall, students in Art 11, Basic Drawing, work under the direction of Lucy Gans, assistant professor of art and architecture.

Of increasing interest to undergraduates are the two-degree, five-year programs that enable one to secure a bachelor's and a master's degree. Because the university's well-established graduate programs are closely integrated with the undergraduate programs, it is possible to consider programs leading to the engineering-master of business administration degree, the engineering master of science in materials program, or the fifth-year program in the graduate-level School of Education that enables those receiving a bachelor of arts degree to accomplish professional teacher training and serve as salaried interns in public schools. After the completion of one year of full-time teaching, secondary teachers can receive the master of arts and elementary teachers can receive master of education degrees.

Many other five-year, graduate-level combination programs exist, and students are advised to consult with their adviser in planning such programs.

Freshman Seminars

Interdisciplinary, problem-centered Freshman Seminars are offered each semester to freshmen enrolled in any curriculum.

A three-credit-hour seminar serves as a General Studies option in the engineering and physical sciences curriculum, a preliminary distribution elective in the arts and science curriculum, or an arts option or free elective in the business and economics curriculum.

Freshman Seminars (FS) have been selected from those proposed by professors who have specified a transdisciplinary inquiry that they would like to pursue in seminar fashion with a group limited to fifteen freshmen. Such study gives each student experience in relating contemporary cultural problems to the many disciplines in the humanities and sciences. It also provides an opportunity to make initial exploration of one or more of those disciplines, thereby helping to season the student's judgment as to how his or her university education could best be structured.

Freshmen interested in enrolling in a Freshman Seminar are invited to use the application form that is part of the Freshman Seminar Announcement each semester, which accompanies preregistration materials. After consultation with the faculty adviser, students submit these applications with other preregistration materials. The class roster for each Freshman Seminar is made up of students from each of the colleges. Beyond that basic restriction, selection of students is made by random choice from among the applicants. Those who apply but are not chosen in the fall semester are given priority in the event they apply again in the spring semester.

Typical Freshman Seminars offered in recent semesters include: Nutrition and Food Supply: The Critical Issues; Productivity—A National Problem; Hope and Systems Thinking; Language in Your Life; World Economic Issues; and Computer Modeling of Our World.

The Harrisburg Urban Semester

Undergraduates in all fields of study can spend a semester studying in Pennsylvania's capital city. They live and work with students from other participating Pennsylvania colleges and are supervised by The Harrisburg Urban Semester (THUS) faculty from participating institutions.

The curriculum consists of an internship, a specialized mini-seminar, and an urban seminar that brings together current interns. Internships, which are the core of the program, are available in federal, state, county, city, private, and religious organizations. They range from environmental protection, prisons and probation, drug rehabilitation, day care, state legislature, mental health, city planning, public works, legal services, and community organization.

Upon completion of the semester, students receive sixteen semester hours of credit.

The Washington Semester

Opportunity is available each year for several juniors or seniors to spend a term studying in Washington, D.C., in

The university's libraries have available more than 7,000 periodicals, so that current information is easily accessible to students and faculty members. Here, in the reading room of Linderman Library, three students taking an economics course review recent copies of The Wall Street Journal. *The students are (from left) Lori Iris Spivak and Lisa Marie Fauci, both majoring in accounting, and Susan Peper, a finance major.*

cooperation with American University. Lehigh University is a member with 180 other colleges and universities.

Students enroll at Lehigh but spend the semester in residence at American University with the students from other participating colleges.

The curriculum consists of national government seminars, an internship, and a written research project. Besides the Washington Semester in national government program itself, the student may choose other program offerings such as the urban semester, economic policy semester, journalism, public administration, foreign policy semester, justice semester, American studies and the Washington Semester in Arts and Humanities.

Honors Programs

The several honors programs are designed to permit students who demonstrate unusual academic ability and interest to explore more widely than their curricula would normally allow and to engage in independent study and research.

Departmental Honors

These programs give qualified students the opportunity to study in the major field more intensively and in greater depth than the standard program provides.

The precise nature of the program for each student is determined by the major department. The program may include:

a. Unscheduled work or independent study (up to four hours per semester in the junior year; up to six hours per semester in the senior year).

b. Waiver of graduate standing: undergraduate students are permitted by petition to the Graduate School or register in a 400-level course for which they have the necessary prerequisites under the conditions that they: have maintained a 3.00 average in each of the two semesters prior to the date of the petition, and will carry a course load not to exceed fifteen credit hours.

c. Honors thesis or project. Candidates for departmental honors announce to their major adviser during the junior year, or no later than the beginning of the senior year, their intention to work for departmental honors. Each major adviser submits to the registrar and the dean of the college, no later than the close of registration of each fall semester, the names of seniors who are working for departmental honors in the particular major.

The names of those students who attain departmental honors are announced at the graduation exercises.

College Scholar Program

The College Scholar program offers the qualified student a unique opportunity for maximum enhancement of critical faculties, abilities, and intellectual interests. This is achieved through a structured program with broad, rigorous standards.

Undergraduates in the College of Arts and Science may apply for acceptance into the program at any time during their career. Application is made to an honors committee, and acceptance is governed by the performance of the student to date and the committee's estimate of the likelihood that he or she will be able to fulfill the requirements of the program.

In order to be graduated with the designation "College Scholar," a student must fulfill the requirements and achieve a cumulative average 3.5. Each program is individually structured and approved by the director. More specific information is contained in Section III.

Honorary and Course Societies

There are fifteen honorary and course societies. The three best-known are:

Phi Beta Kappa. The oldest national scholastic honorary society (founded December 7, 1776, at William and Mary College) recognizes high academic achievement as well as a breadth of interest in the liberal arts and the natural and social sciences. Admission to its ranks is also held to indicate potentialities of future distinction. The Lehigh chapter was chartered in 1887 as Beta of Pennsylvania.

In the electron optical laboratory of the department of metallurgy and materials engineering, metallurgy major Stephen F. Horvath uses an electron microprobe to do an elemental microanalysis of a metal sample. Located in Whitaker Laboratory, the facility has six instruments and is available to students and faculty members from the entire university community.

Beta Gamma Sigma. Election to membership in Beta Gamma Sigma is the highest scholastic honor that a student in business administration can achieve. Beta Gamma Sigma is the only national honorary scholarship society in the field of business administration recognized by the American Assembly of Collegiate Schools of Business.

Tau Beta Pi. Tau Beta Pi recognizes high achievement in all engineering curricula. The national Tau Beta Pi was founded at Lehigh in 1885. A bronze bent in front of Williams Hall commemorates this event.

Other societies are as follows: Alpha Pi Mu, for those in industrial engineering; Beta Alpha Psi, accounting; Chi Epsilon, civil engineering; Eta Kappa Nu, electrical engineering; Lambda Mu Sigma, marketing; Omicron Delta Kappa, leadership; Phi Alpha Theta, history; Phi Eta Sigma, freshman scholastic excellence; Pi Tau Sigma, mechanical engineering; Psi Chi, psychology; Sigma Tau Delta, English; and Sigma Xi, research.

Science, Technology and Society Program

The Science, Technology and Society (STS) program is a broadbased effort on the part of faculty members from all three colleges to foster undergraduate courses concerned with the interrelationships between scientific and technological advancement and the quality of human life.

The STS program offers a minor in Technology and Human Values, consisting of eighteen hours of course credit drawn from a variety of departments. For a full description of the program, see Section V.

Pre-Law Programs

The university has a strong pre-law tradition. In keeping with the policy of the Association of American Law Schools, the university does not have a prescribed prelaw program. Students have been successful in attaining entrance into law schools from diverse curricula within all three of the undergraduate colleges. For more information, see Section III.

Details on the Law and Legal Institutions minor program are found in Section III under listings from the College of Arts and Science.

Presidential Prizes

The university offers each year ten Presidential Prizes valued at $4,000 each, for four years of college. These are reserved for entering freshmen and are awarded on a competitive basis, irrespective of financial need. Each prize provides $500 per semester, credited toward tuition, in any undergraduate college.

The prizes, once assigned, continue in force for the full four years of the student's residence, unless the holder fails to meet the normal scholastic requirement of a 3.00 average or better and the qualifications of a good citizen. In rare instances this requirement may be waived upon unanimous vote of the prize committee and the approval of the president.

In order to compete for one of the prizes, freshman candidate must:

1. Be a successful candidate for admission with evidence of promise of high academic achievement.

2. Submit a separate prize application providing detailed information regarding any important piece of creative work, independent study, evidence of leadership potential, and notable accomplishments that do not appear on the regular record submitted for admission. The applicant should show promise of making an extraordinary contribution to the life of Lehigh.

3. Be interviewed by a member of faculty, generally a member of the prize committee. If distance prohibits a campus visit, the interview may be with a selected alumnus or alumna.

All candidates for admission are automatically eligible to compete for one of these prizes. A preliminary selection of finalists is made in January when prize applications are distributed and interviews conducted. Winners are announced in April. It is possible to receive a Presidential Prize and also qualify for other forms of financial aid. The Financial Aid Form, however, is not required to be considered for a prize.

Prizes will be made in the order of the contestants' ratings on such weighted factors as secondary school scholastic record, evidence of effective leadership and distinguished group service, character and personality, and performance in the College Board tests.

The prizes follow the general plan of the Rhodes Scholarships. Geographic location plays some part in the final selection. Men and women students are equally eligible.

Provisional Courses

A program of provisional courses enables instructional departments to introduce courses temporarily within a semester. Provisional courses are normally either experimental courses or courses based on contemporary social and scientific issues. They may later become part of the regular curriculu if proven successful.

Provisional courses can be taken on a pass/fail basis. Since most courses are not developed in time to be included in course listings, they are identified with a 97-98 (197-198, etc.) number and are incorporated in the registrar's official semester roster for a maximum of two semesters.

Among provisional courses offered during the 1982-83

academic year were the following: Terrestrial Ecology; Chemistry for the Consumer; Comedy and Satire; Antiquity and Beyond; Theories of Culture and Change; Computer Modeling of Our World; Words; Charles Dickens; Introduction to Plate Tectonics; Principles of Public Relations; The Meaning of Life; Issues in Western Religions; The Islamic Tradition; Women and Health; DNA: Discovery, Knowledge, Implications; Eastern European Economics; East Asian Economics; Media Production for Instructional Programming; Peasant Politics; Survey of Middle East II; Japan and World Affairs; Appropriate Technology for Developing Nations; Technological Innovations in Organizations; The Minds of Men and Robots; Reading Brazilian Literature; Asian Religions in America; Christianity and Buddhism; High Magic: A Root of Science and Poetry; Case Studies of Theory Replacement in Science; Research in Theater Technology; and The New Conservatism and Urban Affairs.

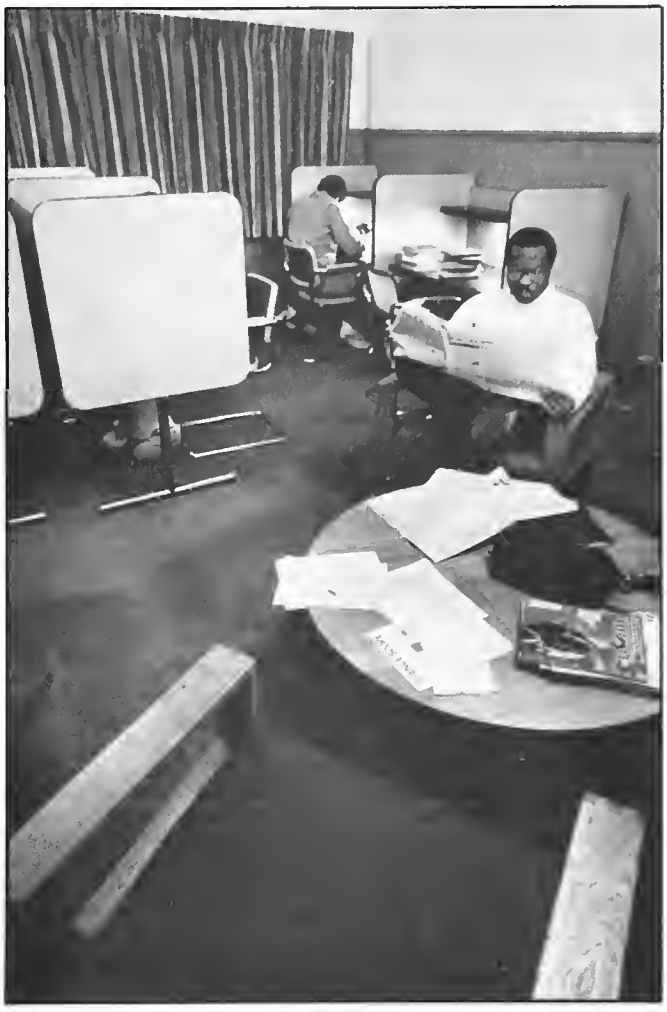
Study in Foreign Countries

To the extent that their courses of study permit it, students maintaining a "B" average or better are encouraged to consider spending one or two semesters of study in acceptable "junior-year abroad" programs or as regularly enrolled students in an institution in a foreign country. Students of foreign languages are especially encouraged to study abroad.

Students must clear their study plans in advance with the registrar and departments concerned so that transfer of credit may be assured.

Among the accepted programs are New York University in Spain; Smith College and Wayne State University in Germany; Sweet Briar College and Hamilton College in France; Dickinson College at Bologna, Italy; University College in Buckingham, England; the University of Kent, England; the University of Manchester Institute of Science and Technology, England; and the University of York, England.

Lehigh, as a member of the Lehigh Valley Association of Independent Colleges (LVAIC), offers summer programs through the association at elementary, intermediate and advanced levels in French and Spanish for Lehigh credit. These programs are currently available in Madrid, Spain, and Poitiers, France. For further details, consult the chairperson of the department of modern foreign languages or call LVAIC.



Finance major Laurence W. Hunter, from Oakland, Calif., reads The Wall Street Journal *in a study lounge in Drown Hall, home of the College of Business and Economics. Availability of specialized publications helps to keep undergraduates current with developments in their field of future employment.*

Non-Academic Resources And Opportunities

While students must have classroom and laboratory work to develop intellectual capacity, research abilities, and critical faculties, learning that occurs outside the classroom is almost as important. It results in well-rounded individuals. The university adheres to the philosophy that a student who finds pleasure in the university experience has the best likelihood of success in academic endeavors, and Lehigh attempts to provide opportunities for students to participate in a variety of experiences outside the classroom. This enhances personal as well as professional development.

Some of the services Lehigh provides for its students are described below, as are a variety of extracurricular activities and events. Often, these are closely related to subjects that students encounter in class—for example, the Computing Society, Mustard and Cheese, various musical groups and numerous other organizations.

Varsity and Intramural Athletics

The university's intercollegiate program consists of a variety of varsity-level sports for men and women, including:

Fall: Football, cross country, soccer, women's field hockey, and women's volleyball.

Winter: Men's and women's basketball, wrestling, ice hockey, indoor track, men's and women's swimming, squash, and rifle.

spring: Baseball, track and field, men's and women's tennis, women's softball, men's and women's lacrosse, golf.

Junior varsity teams compete in baseball, basketball, football, and wrestling. The university intramural and recreational program, offering 27 sports, attracts more than 3,800 participants—65 percent of students.

There is an annual intramural wrestling tournament, the largest of its kind in the nation, and the Turkey Trot three-mile distance run attracts more than 1,000 men and women who take part as teams. The prize is a gigantic turkey, eaten by the winning group.

Lehigh and Lafayette, traditional rivals, will meet on the football field for the 119th time in November, 1983, in the nation's most-played gridiron rivalry. Lehigh has had the upper hand for the past thirty years with twenty wins versus ten losses.

Also, 1983 will mark Lehigh's 100th year of intercollegiate football. Normally the athletic schedule includes five or six home football games, eight or nine home wrestling meets, nine or ten home basketball games,

In Maginnes Hall, home of the College of Arts and Science, two students serve as models in Robert Harson's drama class, demonstrating the staging of plays. The course, English 6, Composition and Literature: Drama, is among the freshman English options open to students in all three colleges. The professor, an actor and director, is a native of New York City who at one time saw three or four plays per week.

nine home baseball games, and home games in all other sports.

The football team won the National Collegiate Athletic Association Division II championship in 1977. In 1978, the football program joined the newly established Division I-AA. The team played in the 1979 and 1980 Division I-AA playoffs.

The Eastern Intercollegiate Wrestling Association tournament will be held in 1983 and 1984 in Lehigh's Stabler Athletic and Convocation Center.

Career Planning and Placement Services

Each student's experience at the university is part of a continuous process of personal and professional self-development. To foster this concept, Lehigh provides career planning and placement services.

Career planning can best be described as an educational process through which students come to understand the relationship between their university experiences and professional opportunities outside the university, and the steps necessary to prepare themselves for those opportunities. Because most people need time to accomplish these steps, students must initiate the process early, explore possible options, and prepare carefully for entry into the career fields they choose.

Through careful career planning, students can use their academic experience to develop individual abilities and skills that they can then relate to professional goals and career opportunities. This process involves learning about various working environments, the skills needed by employing organizations and institutions, and the directions in which a career may evolve.

Students doing career planning should ask not so much, "Where are the jobs?" but, "*What* are the jobs?" Rather than asking, "What can I do with a major in. . . ?", students need to ask, "What is there to do?" For specialized career opportunities, graduate work may be necessary. Students must learn what graduate schools offer the programs they need and what requirements are for admission to those programs.

Placement, another element in the continuous process of career development, is the process of researching specific organizations that provide the types of work desired, and then interviewing for specific jobs through which career or professional objectives can be met. Students learn to ask, "Who hires people to do what I want to do?" This part of the process also requires that students develop skills in such areas as resume writing, interviewing techniques, and job-search strategies.

The goals of the entire career planning and placement process are for students to acquire and develop the skills necessary to become informed and self-sufficient job seekers, and to develop their potential of becoming responsible managers of their own careers. This comprehensive approach can help students to develop satisfying and rewarding careers.

The office of career planning and placement services cannot "get students a job," but it does provide an environment in which talented graduates and exciting career opportunities can find each other. The staff is trained to aid students in resolving questions and concerns about their career aspirations. They offer services and resources designed to help students learn the skills they need to get from where they are to where they desire to be.

To assist in this process, a number of programs and services are available, as follows:

Placement manual. Each semester the office makes available to students the placement manual. This booklet contains information on career planning, how to use the on-campus recruiting system, interviews and plant/office visits, offers and acceptances, job search strategies, and your first job. In addition, there are recruiting schedules, a glossary of entry-level job titles and descriptions, and sample resumes and letters.

On-campus interviewing. The office coordinates and schedules on-campus interviews for approximately 400 organizations, including business, government and graduate schools. During the year, students who are

The research concerns of faculty members are shared by students. Bruce R. Hargreaves, assistant professor of biology, is interested in environmental physiology—ways in which animals function in their natural habitat. In Biology 322, Animal Physiology, he measures oxygen consumed by crayfish, assisted by Benjamin Cooper (left) and Joseph W. Karitis, both biology majors, and Mary Di Nallo, a graduate student.

registered with the office will take approximately 10,000 interviews, or, on the average, thirteen per student.

Workshops. During both semesters, the office staff conducts seminars on resume writing, interviewing skills, and job search strategies and any other areas that students request.

Individual consultations. The staff members are available during weekly "open house" hours and by appointment. Concerns such as choosing a major and/or career path, skills identification, interviewing effectiveness, resume preparation, individualized job-hunting campaigns, etc., can be discussed.

Placement library. Literature, ranging from typical career paths to annual reports, is available for approximately 400 companies. In addition, there is written material on occupational areas and the job-seeking process.

The office, located in Christmas-Saucon Hall, is open throughout the year.

Exhibitions

Exhibitions of various art works are mounted in four principal locations, the Ralph L. Wilson Gallery and the Hall Gallery, both in the Alumni Memorial Building; DuBois Gallery in Maginnes Hall; and the Sculpture Garden in the courtyard east of Mart Science and Engineering Library.

These exhibitions are intended to bring art objects to campus for student use and for the aesthetic appreciation of the community. Artists' participation, gallery talks, lectures, and related events are part of the university's constant program of community art.

Exhibitions planned for the first half of 1983 give a sense of the diversity of interest found at Lehigh. In the early part of the year, drawings and site plans made between 1960 and 1980 by Carlos J. Alvaré, Lehigh faculty member since 1968, highlighted creative architectural design. Next was an exhibition of polished steel and wood sculpture by Joyce de Guatemala, followed by the paintings and drawings of Lee Lippman.

In early spring exhibits included 19th-Century albumen prints of Philadelphia, a selection of American prints from the university collections, and silver prints of the Philadelphia area done by James Bartlett Rich (1866-1942). In March, "Intentions & Techniques" included master works by Brassai, Abbott, Cameron, Bourke-White and Laughlin. Simultaneous with "Intentions" was an exhibition of aluminum sculpture by James Myford.

A tea ceremony with kyoto player was a highlight of the "Tako-Age: Flying Paintings" exhibition. (Tako-age means "soaring kite" in Japanese.) In June, Lehigh alumni were represented. William P. Gottlieb, '38, showed his "Golden Age of Jazz" photographs, which have been given to Lehigh, and Harry L. Rinker, '63, lent his Pennsylvania Dutch frakturs and Moravian silver. Other exhibitions scheduled included selections of American paintings from the Lehigh collection, photographs of European architecture from the same source, and photographs of Mauch Chunk, Pa. (now called Jim Thorpe), home of university founder Asa Packer.

An active gallery talk and lecture series brings artists whose works are being exhibited to discuss their work with students.

A program has been established for museology and museography. A conservation workshop enables undergraduates to understand and practice the care and management of an art collection.

About the University Collections

The university art collection consists of a large variety of art works by old masters and moderns. These works are intended to provide research and study resources for Lehigh students and faculty as well as the community. Specially prepared traveling exhibitions of the collection are loaned to other cultural institutions. Some of Lehigh's important works can be seen at the Allentown Art Museum and the Kemerer Museum in Bethlehem, or, on special request, at the office of the art galleries in Chandler-Ullmann Hall.

The most significant collection is the **Grace Collection**, which includes works of Reynolds, Romney, Gainsborough, Hobbema, Daubigny, Goya, and Inness. Its donor was Marion Brown Grace, widow of Eugene G. Grace, Class of 1899, president of the university board of trustees from 1924 to 1957, and chairman of Bethlehem Steel Corp.

Other collections are the following:

The Dreyfus Collection of French Paintings. This collection includes works by Sisley, Fantin-Latour, Bonnard, Vuillard, Signac, Redon, Courbet, and Picasso. It was contributed by Jack J. Dreyfus, Jr., '34, of New York City, founder of the Dreyfus Fund and the Dreyfus Medical Foundation.

The Ralph L. Wilson Collection of American Art. This collection includes paintings by such artists as Prendergast, Sloan, Henri, Luks, Lawson, Bellows, Beal, Glackens, Hartley, Marin, Burchfield, and Zorach, and prints by Whistler, Feininger, Hassam, Taylor-Arms, Pennell, Motherwell, Johns, Hayter, Oldenburg, Warhol, Calder, Rivers, Bearden, Rauschenberg, Ortega, Dali, Tobey, Sutherland, Genovese, D'Arcangelo, Paolozzi, and Marca-Relli.

The late Ralph L. Wilson, '21, the donor, served on the university board of trustees. A gallery in the Alumni Memorial Building is named in his honor.

The Prasse Collection of Prints. This collection, donated by Leona E. Prasse, the former curator of prints at the Cleveland Museum of Art, includes works by European and American artists, including Delacroix, Matisse, Renoir, and Blampied.

The Austin Collection. This collection was contributed by Dr. James B. Austin, '25, who received a Ph.D. from Yale in 1928 and an honorary Sc.D. from Lehigh in 1962, and retired as administrative vice president of research and technology from the United States Steel Corp. It contains Buddhist and traditional Japanese prints.

The Bocour Collection of Contemporary Paintings. The collection contains a variety of paintings by contemporary artists such as Chernov, Pollack, Dovaiby, and Langlais. Its donor, Leonard Bocour, is president of Bocour Artist Colors, Inc., a manufacturer of artist's pigments and acrylics.

The Philip and Muriel Berman Collection of Japanese Prints. The collection contains contemporary and historical prints by such artists as Utamaro, Inove, Saito and Onchi. Philip Berman is chairman of the board of Hess's department stores; the main store is located in Allentown with branches throughout Pennsylvania. He and his wife, Dr. Muriel Berman, are well-known patrons of the arts.

The Philip and Muriel Berman Collection of Contemporary American Sculpture. The collection includes the works of well- and lesser-known contemporary sculptors, both American and foreign, who work in wood or metal. Many of the works, by such sculptors as Kadishman, Peleg, Zweygardt, Sisko, Sternal, Simon, Althouse, Bertoia, Reik, Ihlenfeld, and de Guatemala, are on display in the quadrangle behind the Seeley G. Mudd chemistry complex, and in the Saucon Valley athletic complex.

The Fearnside Collection of Drawings, Etchings, Paints and Oils. This collection is on loan to the university by Viola M. Fearnside in memory of George W. Fearnside, '28. It is an extensive collection of works by master and unknown European artists.

Guidance and Assistance

General counseling of individual students, especially in the freshman year, begins with the residence halls counselors, who are known as Gryphons. These counselors are carefully selected upperclassmen who help the first-year students and who direct them to more highly specialized aid when needed.

Freshmen whose problems transcend the competence of the Gryphons come to other advisers for guidance in many areas of student life and welfare. Problems of vocational choice and academic adjustment are not uncommon, particularly during the freshman and sophomore years. At all levels, academic and procedural questions, personal problems, social adjustment difficulties, and other troubles are dealt with daily.

The office of the dean of students serves as a central agency in helping students with their problems and concerns, both through its staff and through referral to other student personnel and academic offices.

Students with legal problems should consult the office of the dean of students for direction concerning legal counsel.

Not all student problems are individual problems. Many are group problems, having to do with group living in the residence halls, with student activities, student organizations, fraternity and sorority life, and campus social life in general. The deans and their assistants give much time to these areas of student life.

Each college provides advisers to aid students in academic decisions. Each student in the College of Arts and Science is assigned a freshman adviser with whom academic interests are discussed prior to registration. The choice of studies is carefully organized in terms of specific backgrounds of preparation and future objectives. Individual advising continues throughout the student's four years in the college.

In the College of Business and Economics, faculty advisers work with the student concerning his or her individual academic problems and course preparation. Similarly, an associate dean of the College of Engineering and Physical Sciences spends much time with the freshman engineering students in an effort to help in the adjustment of academic difficulties and in better definition of vocational objectives. These forms of advisement are carried on through the following years with the student's academic advisers.

When a student's problems require more specialized attention, referral is made to the particular service that should be consulted. Problems of mental or physical well-being are, of course, referred to the university health service. The university chaplain is available for the student with religious, moral, or personal concerns that are interfering with his or her peace of mind and studies. A Roman Catholic chaplain also is in residence and available for counseling. A member of the faculty serves as adviser to Hillel Foundation members, who also may obtain spiritual advice from a local rabbi.

If a student is uncertain about vocational plans or needs to know more about his or her own capacities, interests, or personal characteristics, the university counseling service is available without charge. Confidential interviews may be secured by any student who wishes to review his or her own progress and further evaluate and refine his or her thinking about future goals. Personal counseling is offered for those students who may need and desire it. The counseling service works with health services in matters of mental health.

In the senior year, the question of prime importance is the decision on a position after graduation. The staff of the office of career planning and placement services, in personal and group conferences, advises on applying for a position, on being interviewed, and on the relative advantages and disadvantages in working for the different business and industrial firms and other employers seeking the services of college graduates.

Financial concerns can become serious problems for a student. The director of financial aid is available for consultation on these problems.

If a student is a veteran of military service and has questions involving relations with the Veterans Administration, he or she should contact the registrar. The registrar also is an adviser on military service, on matters of transferred credits, graduation requirements, and allied topics.

Poor study habits or reading skills may be impediments to success in a student's academic life. The Learning Center can provide help.

Many members of the teaching faculty are deeply interested in students and student life and spend a great deal of time working with student groups. They contribute their services as academic advisers, activity sponsors, group sponsors and advisers, by entertaining in their homes, and in friendly personal relationships with students.

In these and in other ways Lehigh University endeavors to maintain the close contacts with students that characterize the smaller institution. Services are available for all student needs, and the student need only turn to his or her nearest residence hall counselor, professor, or the *Lehigh Handbook* to learn where help can be obtained.

Counseling Service

The counseling service, located in Johnson Hall, offers the opportunity for consultation with clinical psychologists and other counselors in regard to a wide variety of problems ranging from those concerns that arise during the course of normal development to more debilitating emotional disturbances.

In cases where pertinent and objective information concerning academic ability, vocational interest or social-personal adjustment is desirable, psychological tests are often administered. Such test batteries are available at every student's individual option. Interpretation of the tests is intended to help the student achieve maximum effectiveness in course work and studying, professional development, and campus life. The test scores are utilized as only one of a number of sources of information important to wise and effective planning. Where appropriate, cross-communication with other university advisers is undertaken in gathering together information and expediting plans made cooperatively with the student.

The counseling service maintains a career information library, to which students can refer as they attempt to develop a clear conception of the educational and vocational world and how they fit into this world. Objective data concerning educational and occupational opportunities are important factors in effective decision-making skills.

When a student is generally uncertain, confused and unable to plan for the future with confidence, he or she may undertake personal counseling aimed at helping the individual understand his or her direction and motivation.

Psychotherapeutic counseling, in particular, encourages the student to explore the sources of his or her feelings, to consider their influence on behavior, and to discover new ways to manage one's own affairs more effectively. Personal psychotherapeutic interviews would be intense and likely to involve conferences over an extended period of time.

Both testing and counseling services are available, without cost, to all university students; all interviews are held in confidence.

Some specialized services offered include test anxiety desensitization, personal and social anxiety reduction, and meditative relaxation. Training in these self-management techniques may be administered alone or in conjunction with psychotherapy.

Although student counseling is its major professional activity, the counseling service is also the administrative center for a variety of local and national testing programs in which students might wish to participate during their college career. The most frequently administered of these programs are the Graduate Record Examination, Law School Admission Test, Graduate Management Admission Test, and the Miller Analogies Test.

The service also engages in research on tests, counseling and other functions. The results of such research are ultimately useful in the counseling of individual students.

Guest Speakers

Students have the opportunity to hear a wide variety of notable speakers. Students are welcome to attend speeches free of charge. In addition to the nationally known speakers, the university regularly presents scholars in many disciplines. Many speakers appear under the auspices of the Visiting Lecturers Committee.

Among recent outstanding speakers were former U.S. Sen. Richard S. Schweiker, secretary of health and human services in the Reagan cabinet; consumer advocate Ralph Nader; ERA advocate Karen De Crow; Phyllis Schlafly; Gloria Steinem; Abbie Hoffman; Lettie Cottin Pogrebin; conservative columnist William F. Buckley, Jr.; Betty Williams, from Northern Ireland, winner of the Nobel Peace Prize; writer Isaac Asimov; labor columnist Victor Riesel; scientist Rollo May; Muhammad Ali; Israeli Gen. Moshe Dayan; George McGovern; Richard Davies, former U.S. ambassador to Poland; George Sheehan, the author, runner, and cardiologist; poets Maya Angelou and Nicki Giovanni; Leonard Woodcock; writers Jimmy Breslin, Isaac Bashevis Singer, Toni Morrison, and John Cole.

In economics, the university has hosted John Kenneth Galbraith, the Harvard-based economist; Marina von Neumann Whitman, the first woman ever to have served as a member of the Council of Economic Advisors; and Rosabeth Moss Kantor, a Yale sociologist and management consultant.

The Rocco J. Tresolini Lecture in Law, established in 1978, featured Laura Nader, professor of anthropology at the University of California at Berkeley, in 1981; John Hart Ely, from Harvard Law School, in 1982; also, Antonin Scalia, who was appointed Judge of the United States Court of Appeals for the District of Columbia in 1982. This annual lecture series, sponsored by the university's Law and Legal Institutions program, is made possible by gifts from the Class of 1961 and other alumni and friends of the university. Dr. Tresolini, who died in 1967, was a distinguished scholar in the field of American constitutional law and the first chairman of the department of government at Lehigh.

The Andrew W. Mellon Lecture Series, supported by a grant from the Mellon Foundation, brings to the campus speakers with a special interest in the social and human impact of science and technology. Past lecturers have included such notable people as Nobel laureates C.N. Yang and Rene Dubos; historians of technology Jean Gimpel, Melvin Kranzburg, and Carroll Pursell; Hans Bethe, a Nobel Prize-winning physicist; computer-science pioneer Joseph Weizenbaum; and *New York Times* science editor Walter Sullivan. The series is coordinated by the Science, Technology, and Society program.

In addition to the above, students also hear speakers who have expertise in a variety of fields of inquiry. In addition, there are outstanding speakers for major university events. For example, the 1983 commencement speaker will be Lee A. Iacocca, '45, chairman of Chrysler Corp.

The Learning Center

Success at Lehigh depends in part on mastery of a number of advanced academic skills. Such skills are needed to study effectively (prepare assignments, take notes, outline, listen, recall information), to take examinations, to prepare oral and written reports, to understand advanced mathematical concepts, and to keep up with a great deal of critical and comprehensive reading.

At Lehigh, a campus noted for its highly motivated student body and strenuous academic program, 7 percent of undergraduates, including 21 percent of full-time freshmen, use the tutorial services of The Learning Center. Established in the fall of 1977, it provides a schedule of workshops, review sessions, and, most importantly, individual tutorials in study skills, mathematics, physics, reading, writing, and English as a Second Language. Through a program of faculty and student referrals, along with periodic notices to the student body, the Center helps students to improve specific communication and mathematical skills, to maintain acceptable performance levels, and to raise their academic standing. Individualized assistance is emphasized.

The Learning Center provides university students with a continuing opportunity for academic improvement through personalized instruction by professors, graduate teaching assistants, and a technical staff, and through a program of services that includes a language learning

laboratory, a computer console with access to the university's programming, and a variety of audio-visual materials. The center is located in Coppee Hall.

Of Musical Interest

The university sponsors both a variety of student musical organizations that give performances on and off campus and a professional concert series, Music at Lehigh, that brings visiting artists to the campus. The choruses, bands, orchestra and ensembles are conducted by members of the faculty and managed by elected student leaders.

Christmas Vespers and Spring Vespers are traditional choral performances. Recent audiences have heard the *Passion According to John* of J.S. Bach, Mozart's *Mass in C Minor*, and Gian Carlo Menotti's madrigal opera, *The Unicorn, the Gorgon, and the Manticore*, Stravinsky's *Les Noces*, and the Faure *Requiem*. The university choir has toured Canada, Puerto Rico, the Virgin Islands, Washington, D.C., and throughout Pennsylvania.

The concert band regularly plays at the winter band and pops concert. Performances of pieces by Stravinsky, Ruggles, Rossini, and P. D. Q. Bach have highlighted past concerts. The concert band has performed in Florida, Washington, D.C., and on the campuses of other colleges and universities. The concert band also sponsors a jazz ensemble that is student-directed. It performs on campus and plays at jazz festivals around the country.

Performances by the string orchestra and the ensembles traditionally close the semester concert season. The ensembles include groups of string, brass, woodwind, percussion and mixed instruments. Recent additions have been ensembles of Renaissance instruments from the university collection.

The Lehigh University Very Modern Ensemble (LUVME) is the newest musical group on campus. The ensemble combines students, faculty, and professional musicians who perform the music of the 20th Century. Pieces such as Milhaud's *Creation of the World*, George Crumb's *Ancient Voices of Children* and Terry Riley's *In C* have recently been performed. LUVME also sponsors concerts of music by Lehigh student composers and annually brings a composer of national reputation to campus in order to discuss and play his/her music.

The "97" marching band is widely known for its imaginative and spirited performances on the gridiron and in the stands in support of the Lehigh football team. Pregame and half-time performances are precision drills with a varied repertoire from classical music to traditional fight songs. The band is comprised of 97 men and women with nine students serving in executive positions. The band appeared at Wichita Falls, Texas, and in Orlando, Fla., accompanying the football team in postseason games.

The concert series Music at Lehigh presents a variety of concerts and recitals. Some of the artists who have appeared are the Orpheus Chamber Orchestra; Calliope: A Renaissance Band; the Performer's Committee for Twentieth-Century Music. Inaugurated in 1980, the Ralph Van Arnam Chamber Music Series presents concerts of outstanding chamber music; the series honors the memory of a Lehigh faculty member.

Private instrumental and vocal lessons with instructors approved by the music department are open to all students. The cost of lessons is in addition to tuition expense.

A variety of musical artists is presented by the Student Activities Council and by other groups on campus. Students receive further exposure to music through bands hired by individual living groups to perform for weekend parties.

Theater at Lehigh

The division of speech and theater and the Mustard and Cheese Dramatics Society, an extracurricular organization founded in 1884, work together to produce an average of four main stage productions annually, ranging from the avant garde to classical dance and musical comedy. Qualified students may act, direct, design or otherwise participate in the many facets of theater production. Productions are mounted in Wilbur Drama Workshop.

Independent student theater work is encouraged through the Lab Theater program and by two active student dance groups. Through the Yale Playwrights Program, students have the opportunity of working on new plays written by Yale students of playwriting. From time to time students work with guest artists, and opportunities are also available to see touring theatrical productions brought to campus.

A recent development in the design area is use of computers to help design sets, teach technical theater concepts, and aid in stage lighting.

II

Information of General Interest

This section includes information for prospective students and undergraduates related to admission, accreditation, advanced placement, transfer students, tuition and fees, financial aid, academic regulations, and university resources. Similar information for graduate students may be found in Section IV. The university history, mini-biographies of its presidents, listings of buildings, and maps are found in Section VI.

Accreditation

Lehigh University is accredited by the Middle States Association of Colleges and Schools.

Specialized programs in business administration are accredited by the American Assembly of Collegiate Schools of Business. The engineering curricula are accredited by the Accreditation Board for Engineering and Technology. Various School of Education programs are accredited by the National Council for Accreditation of Teacher Education, including Commonwealth of Pennsylvania approval for certification programs. Programs in chemistry are approved by the American Chemical Society.

Policy of Equality

It is the policy of Lehigh University to provide equal opportunity on the basis of merit and without discrimination because of race, color, religion, sex, age, national origin, handicap, or veteran status.

Admission Guidelines

The enrollment of Lehigh University is regulated by action of the board of trustees, with a resulting limitation in the number of candidates who can be admitted each year to the several divisions of the university.

In the selective procedure necessitated by limitation on enrollment, the university, through its office of admission, takes into account a number of criteria that are believed to have some individual validity and in combination a high degree of validity in predicting success in college work.

The material that follows pertains to undergraduates. Graduate students should consult Admission to Graduate Standing, Section IV.

The admission policy of the university is designed to encourage students with varied backgrounds to consider study at Lehigh. The courses or units required for admission represent the quantitative equivalent of the usual four-year college preparatory program and include certain prescribed subjects for candidates depending upon their college and curriculum choice.

An applicant's full potential as a Lehigh student, including evidence of academic growth and the desire to learn, are special qualities that may not be reflected in mere accumulation of units. Such qualities are considered when appraising applicants.

All applicants should have completed four years of English, two to four years of history and social studies, three or four years of mathematics, and two to four years of laboratory science. Chemistry is required and physics recommended for candidates planning studies in science or engineering.

Students planning to enter the College of Engineering and Physical Sciences or the College of Business and Economics, or the bachelor of science program in the College of Arts and Science, must have studied mathematics through trigonometry.

Students planning a bachelor of arts degree in the College of Arts and Science present credit upon entrance for at least two years of study of one foreign language. Further foreign language study is strongly encouraged.

One of the attractive features of the university is the ease with which a student may normally transfer from one curriculum or college to another. A student must, however, be enrolled in an undergraduate college for two semesters

and be in good standing, before transferring to another college. Such transferring may necessitate a student's obtaining additional background for the new discipline on campus or elsewhere.

Minimum subject matter requirements (16 units)
English 4
foreign languages* 2
college preparatory mathematics** 4
electives 6

*Only in exceptional cases and for otherwise well-qualified candidates will waivers of the requirement in foreign languages be granted for admission to any one of the three undergraduate colleges.

**Waivers of the requirement in mathematics are granted to otherwise well-qualified candidates for admission who propose to major in one of the following fields offered by the College of Arts and Science: American studies, art, classics, theater, English, modern foreign languages, government, history, international relations, journalism, music, philosophy, religion studies, social relations, and urban studies.

Note: Electives should include such college preparatory subjects as languages, social studies, and sciences.

The quality of the candidate's work is more important than merely meeting minimum subject matter requirements.

The strength of preparation is judged primarily by rank or relative grade in class; by the extent to which grades are distinctly higher than the average grade; by evidence of improvement or deterioration in quality of record as the secondary school career progressed; by relative success in the subjects the student proposes to continue in college; by the degree of difficulty of courses—particularly in the senior year; and by the comments and recommendations of the principal or headmaster.

Entrance Examinations

All candidates for admission to the freshman class are required to write entrance tests prepared and administered by the College Board. It is the responsibility of the student, not the school attended, to request the College Board to report official scores to Lehigh.

Scholastic Aptitude Test. Each candidate is required to write the Scholastic Aptitude Test (SAT) to provide the university with a measure, on a national scale, of aptitude and readiness for college study. The university prefers that this test be written early in the senior year. Many students write the SAT in the junior year and ask the College Board to report the results to Lehigh. In some cases it is not necessary for students to repeat this test in the senior year.

Achievement Tests. Each candidate is required to write three College Board Achievement Tests. One of these must be an English test.

Candidates for a science program in the College of Arts and Science or for a program in the College of Engineering and Physical Sciences are expected to write a Mathematics (Level I or Level II) Achievement Test. Candidates for the College of Engineering and Physical Sciences are expected to write a Science (chemistry or physics) Achievement Test.

Candidates for a bachelor of arts degree from the College of Arts and Science, including five-year Arts-Engineering candidates, should write an Achievement Test (or Advanced Placement Examination) in any foreign language to be studied in college. Other candidates write tests that they may choose in consultation with their advisers. The English test and two additional Achievement Tests should be written in the senior year, unless satisfactory junior-year scores were submitted to Lehigh University.

Test information and applications may be secured from schools or the College Board at either of the following addresses (whichever is closer to the candidate's home or school): P.O. Box 592, Princeton, N.J. 08541, or 1947 Center St., Berkeley, Calif. 94704. Candidates writing tests outside the United States should direct their correspondence to the Princeton address.

Candidates should register for the tests early in the senior year and not later than one month prior to the test date (two months for candidates who will be tested in Europe, Asia, Africa, Central and South America, and Australia).

The candidate is responsible for requesting that the test scores be sent to Lehigh University—either by indicating Lehigh on the College Board application or, having failed to do this, by request to the College Board office.

Other Criteria and Interviews

Information about other qualifications of candidates is obtained from principals or headmasters, and counselors. Such information relates to the candidate's health, emotional stability, intellectual motivation, social adjustment, participation in school activities, and established habits of industry and dependability.

Each candidate is encouraged to visit Lehigh University so that he or she may see the university or talk with an officer of admission. An appointment should be made in advance of the visit. Write to Samuel H. Missimer, director of admission, Lehigh University, Alumni Memorial Building 27, Bethlehem, Pa. 18015. The telephone number is (215) 861-3100.

The office of admission is open for interviews every weekday between 9 and 11 A.M. and from 1:30 to 4 P.M. Tours of the campus are available weekday afternoons when classes are in session. Interviews also are available on some Saturday mornings in the fall. (Classes are not in session on Saturday.) Visitors are welcome during the summer months. The office of admission is closed on Saturdays except in the fall, and on Sundays and national holidays. Interviews are not held from mid-February to April 1, when applications for the fall class are being reviewed.

Although a personal interview is not required of all candidates, the university reserves the right to require an interview whenever this appears desirable or necessary, and to base determination of admission in part on the report of the interviewer.

How to Apply

Students may secure applications by writing to the Office of Admission, Alumni Memorial Building 27, Lehigh University, Bethlehem, Pa. 18015, or by telephoning (215) 861-3100. Applications should be filed no later than March 1. Preference is given to those received by January 1.

Application fee. Each undergraduate application for admission must be accompanied by an application fee. The fee is nonrefundable, whether or not the candidate matriculates at Lehigh University. It does not apply toward tuition.

Early decision. The university will give candidates an early favorable decision on their applications if they meet the following criteria: 1. the person is certain that Lehigh is the first choice of college; 2. preliminary credentials, including Scholastic Aptitude Test scores, show clear qualification for admission.

On this basis the committee on admission selects candidates who have submitted requests for early decision by November 1. The decision will be made by December 1. If the decision is favorable, it is assumed the candidate's academic strengths will continue throughout the senior year of high school and that all admission requirements will be completed. On receiving a favorable decision, the candidate promptly withdraws other applications and does not apply elsewhere.

Early-decision candidates whose parents have submitted the Financial Aid Form receive notice by December 15 of the action taken on requests for financial aid.

The early-decision plan is not appropriate for all

candidates. There are many candidates who are unable to make an early college choice, and they are not penalized. Candidates who do not receive favorable replies to their requests for an early decision should not feel discouraged. Only a portion of the class is selected under this plan. The committee on admission prefers to take action on most applications later in the academic year.

Admission and Deposit

Selection of candidates for the freshman class entering in August is made between mid-February and April 1 following receipt of College Board scores and preliminary secondary school records. The university subscribes to the Candidates' Reply Date, which has been set at May 1.

When preliminary credentials are complete and the person has been offered formal admission, the university will request that the student notify its director of admission of acceptance of the offer. A deposit of $50 is also requested by Lehigh at this time to hold the place for the student in the limited enrollment. This deposit is not an additional fee but is applied toward tuition charges for the first semester. However, the deposit is forfeited in case of failure to enroll for the specified semester.

Advanced Placement

The university offers capable students who have superior preparation an opportunity for advanced placement and/or college credit. Many secondary schools, in association with the College Board, offer college-level work. Students participating in these courses should write the advanced placement tests offered by the College Board.

Students who achieve advanced placement are afforded three major advantages. First, they commence study at Lehigh at a level where they will be academically comfortable. Second, students who qualify for college credits may be graduated at an earlier time—with resulting savings in time and tuition outlay. Third, qualified students may, in the Lehigh senior year, enroll for a limited amount of work for graduate credit.

Entering freshmen who ask the College Board to send their advanced placement grades to Lehigh are considered for advanced placement. Grades range from a low of 1 to a high of 5.

Departments noted below offer examinations during Freshman Orientation to students who studied college-level subjects in secondary school but did not write the advanced placement tests. Entering freshmen wishing to write an examination in any Lehigh course should notify the office of admission in writing prior to August 1. The student should specify the number and title of the course. Students who receive credit on the basis of advanced placement grades need not write Lehigh tests to confirm the credit granted.

Current practice at Lehigh is as follows:

Art and architecture. Three semester hours of credit are given to those students who earn grades of 3 or higher on the advanced placement history of art examination. Those students who earn grades of 3 or higher on the advanced placement studio art examination also receive three credits.

Biology. Three semester hours of credit for Biol 21 are given to those who earn grades of 4 to 5.

Chemistry. Eight semester hours of credit for Chem 21, Chem 22, and Chem 31 are granted to students who earn a grade of 5. Those students who earn a grade of 4, or who score 750 or higher on the chemistry achievement test, are granted five hours of credit for Chem 21 and Chem 22 and may apply to the department for a special examination that, if completed successfully, will result in an additional three hours of credit for Chem 31.

English. Advanced placement and six semester hours of credit for freshman English are given to students who earn a grade of 5. These students need not take the regular freshman English courses, but they are encouraged to elect Engl 11 and 12, seminars designed to give advanced freshmen practice in reading and writing at the college level. Students who receive a grade of 4 or who have a score of 700 or higher on the verbal section of the Scholastic Aptitude Test or the English Composition Achievement Test receive three hours of credit in freshman English; these students complete the six-hour requirement by taking an English course suggested by the department. Students whose verbal scores are between 650 and 690 and who have received a grade of 3 on the advanced placement test may apply to the department for a special examination that, if completed successfully, will result in three hours of credit and exemption from Engl 1.

History. Students who receive 3 on the American History or European History Test receive advanced placement but not credit. Those who earn scores of 4 or 5 on the American History test receive six semester hours of credit; those who earn scores of 4 or 5 on the European History test receive three semester hours of credit. A special course, Hist 51, is available to qualified students.

Latin. Students receive three semester hours of credit for a grade of 4 or higher in the Vergil examination; those who successfully write examinations in more than one area (e.g. Vergil and lyric poetry) receive six hours of credit.

Mathematics. Four semester hours of credit for Math 21, Analytic Geometry and Calculus I, are granted to those who earn grades of 3 or higher on the Calculus AB examination. To those who earn grades of 3 or higher on the Calculus BC examination, eight hours of credit are granted for Math 21 and Math 22, Analytic Geometry and Calculus I and II.

Modern foreign languages. (French, German, Hebrew, Russian, Spanish). Students receive three semester hours of credit for grades of 4, and six hours of credit for grades of 5 on the advanced placement tests. Those who write the achievement tests and score 750 to 800 receive three hours of credit.

Music. Three semester hours of credit are given to those students who earn grades of 3 or higher on the advanced placement music theory examination.

Physics. A student receives 4 hours of credit for Phys 11, Introductory Physics I, for a grade of 5 on the Physics B examination, or a grade of 4 on the mechanics section of the Physics B examination, or a grade of 4 on the mechanics section of the Physics C examination. If a student receives credit for Phys 11, 4 hours of credit will be given for Phys 21, Introductory Physics II, for a grade of 4 on the electricity and magnetism section of the Physics C examination. If a student wishes to be considered for credit for Phys 12 or 22, Introductory Physics Laboratory I or II, he or she should see the chairman of the physics department with evidence of laboratory experience.

International Baccalaureate. Students who earn the International Baccalaureate are granted credit in higher-level subjects in which they earn scores of 4 or higher.

Transfer Students

Each January and August, students who have attended other colleges and universities are admitted with advanced standing. Candidates for transfer admission must meet the high school subject matter requirements prescribed for entering freshmen. Entrance examinations are not required. The quality of the college record and the number of spaces available in the program the student wishes to study are the major considerations of the committee on admission in reviewing transfer applications.

A candidate who has been dropped from another college for disciplinary reasons or for poor scholarship or who is not in good standing at another college is not eligible for admission.

A candidate who has attended more than one junior college, college, or university must present an official

transcript from each institution. Failure to submit a complete report of academic experience will result in cancellation of admission or registration.

Those students wishing to enter in the spring semester should apply not later than October 1; fall semester applicants should apply no later than April 1.

Students may obtain applications by writing to the Transfer Section, Office of Admission, Alumni Memorial Building 27, Lehigh University, Bethlehem, Pa. 18015, or by telephoning (215) 861-3100.

When the receipt of the application is acknowledged by the office of admission, the student is advised of the time when transcripts and other documents should be submitted. Decisions on applications are reached soon after the middle of the semester preceding the one the student wishes to enter the university.

Estimate of Expense For Undergraduates

The operating expense of Lehigh University is supported principally by three areas of income: tuition and fees, endowment earnings, and gifts and grants. The university is conscious that educational costs are significant and strives to maintain a program of high-quality instruction while recognizing that there are limitations on what families can afford to pay. The costs will vary somewhat from student to student depending upon the various options chosen.

Tuition, Room, and Board

There are three major plans that cover major expense associated with university attendance. These are as follows:

The Tuition Plan. The university provides comprehensive academic and student services under its tuition plan. The tuition sum is inclusive of most athletic events, basic treatments in the Health Services facilities, libraries, and laboratory services. The full-time tuition rate is charged to students enrolled in twelve or more credit hours per semester. For students enrolled in less than twelve semester hours, tuition is charged on a per-credit-hour basis.

The Residence Halls Plan. A variety of living arrangements are available. The university provides housing for 2,200 students on or near the campus in a wide selection of housing facilities. The housing arrangements are grouped within three basic categories, with rates associated with the category level. In order to guarantee a space within a residence halls unit, a $100 deposit is required for each semester. This deposit is credited toward the room charge for the respective semester. For entering freshmen, the deposit is not refundable if they make other plans. For returning students, the fee is refundable based upon a published schedule.

The Board Plan. Six board plans are available. The basic 21-meal-per-week plan is required of all freshmen in residence. Upperclass students living in residence halls have the option of participating in any of the plans providing ten or more meals per week. Students residing in fraternities, sororities, campus apartments, or off-campus facilities are eligible to participate in any of the plans.

Tuition and Fees

All charges and fees are due two weeks prior to the start of classes each semester. On a per-term basis, the expenses are charged at one-half the per-year charge. Accounts not settled by the due date are subject to a late-payment fee.

Tuition, 1983-84	**$8,000**
Residence Halls	
Category I (Dravo, Drinker, Richards, and McClintic-Marshall houses)	1,400
Category II (Centennial Houses I and II, Warren Square, Hill House, and Taylor House)	1,580
Category III (Trembley Park, Brodhead House, and Polk Gardens)	1,700
Board	
Plan A (21 meals per week, required of all freshmen)	1,320
Plan B (17 meals, Monday breakfast through Saturday lunch)	1,280
Plan C (15 meals, Monday breakfast through Friday dinner)	1,210
Plan D (10 meals, lunch and dinner Monday through Friday)	1,180
Plan E (5 meals, lunch Monday through Friday)	440
Plan F (5 meals, dinner Monday through Friday)	740

Based upon the above charges, most freshmen are normally billed the tuition rate along with the Category I room fee and the Plan A food plan. The total cost for the three areas would be $10,720 for the 1983-84 academic year.

Other Fees (applied to prevailing circumstances)	
Per-credit charge for credit and audit	335
Application fee (for admission consideration)	25
Preregistration revision	10
Late preregistration	25
Late processing	50
Late registration	25
Late application for degree	25
Examination makeup (after first scheduled makeup)	5
Late payment (after announced date)	25
Returned check fine	10
Key penalty, residence halls (nonreturn)	10
Key duplicate, residence halls	3
Food Service card (replacement)	10
Identification card (replacement)	5

The university reserves the right at any time to amend or add charges and fees, as appropriate, to meet current requirements. Fees applicable to the 1984-85 academic year will be announced no later than January, 1984.

Other Expenses

A student should plan to meet various other expenses. These expenses include the purchase of books and supplies from the Lehigh University Bookstore located in Maginnes Hall. Necessary purchases supporting one's academic program should average approximately $300 per year. The bookstore carries basic goods for students' needs. A student should also plan an allowance to handle personal and travel expenses.

Plan of Payments

An itemized statement of charges is mailed from the bursar's office approximately six weeks prior to the start of each semester. Payment is expected in full by the specified due date. Payment plans are available for those desiring extended payment arrangements.

Persons desiring a payment plan can elect participation in either the Girard Trust Edu-Check Plan or the Richard C. Knight Tuition Plan. Complete information is available from the bursar's office. Those persons desiring to use one of the plans must complete the necessary details no later than two weeks prior to the due date for payment.

Students attending the university under a provision with a state board of assistance or with financial aid from other outside agencies must provide complete information to the bursar's office if assistance is to be recognized on the semester statement.

Refunds of Charges

Tuition refunds. A student in good standing who formally withdraws (within the first eight weeks of a semester) or reduces his or her course enrollment below twelve credit hours will be eligible for a tuition refund. The refund schedule for student withdrawals and course adjustments is as follows:

prior to the start of the semester	full, less $100 deposit
during first calendar week	80%
during second calendar week	70%
during third calendar week	60%
during fourth calendar week	50%
during fifth calendar week	40%
during sixth calendar week	30%
during seventh calendar week	20%
during eighth calendar week	10%

Full-tuition refunds will be allowed for registration cancellations, or reductions in rosters, only in those instances when a notice is presented in writing to the registrar prior to the start of a semester. Cancellation and reduction notifications received after the start of a semester will be recognized based upon the calendar week in which it is received by the registrar.

In the event of an untimely death of a student, tuition will be refunded in proportion to the semester remaining. Any student suspended or expelled from the university will not be granted a tuition refund.

Residence halls refunds. Residence hall rooms are rented on an annual basis only. Refunds are made in full in the event a student does not register because of illness, injury, death, or is dropped from the university due to academic reasons. Partial refunds during the year are possible only in the event of a voluntary withdrawal and with the provision that the student can transfer the lease to another student for whom no other university accommodations exist.

Prorated refunds are based upon the date the room keys are returned to the residence operations office. An advance deposit of $100 for each semester is required to hold a room for the respective semester. This deposit is nonrefundable to entering freshmen and partially refundable to returning students based upon a published schedule.

Refunds for food plans. Board refunds are based on the number of unused days remaining in the board plan at the time the plan is discontinued. The prorated refund is based upon the date the meal card is returned to the bursar's office. Refunds are granted based upon voluntary withdrawal, illness, or death.

Financial Aid

The university offers financial aid opportunities to students who are U.S. citizens and permanent residents, and who have demonstrated financial need and academic promise. The competition for scholarship funds is keen.

Approximately 30 percent of the 1983 freshman class will enroll with university scholarships ranging, according to need, from $100 to $6,000. An additional thirty percent will enroll with aid from sources other than Lehigh, including state and federal grants, ROTC scholarships, aid from private sources and guaranteed student loans.

Because competition for available funds becomes intensive, it is important for those desiring financial aid to heed the regulations for filing required forms.

Applications for admission are reviewed without regard to whether or not the applicant desires financial aid. Therefore, it is possible to receive favorable consideration for admission but not receive university aid. (Such is the case with foreign students, who are welcomed at Lehigh even though financial aid cannot be provided.) Even students who do not receive university aid are being subsidized because at an independent university like Lehigh tuition covers approximately sixty percent of the cost. Remaining expense is met by income from endowment funds and through gifts and grants from alumni, friends, corporations and foundations.

For those who desire to be among the aid recipients, it is advised that the time be allocated to read and understand what follows. Otherwise, an opportunity could be missed.

Philosophically, Lehigh expects that all families of its students will make every effort to pay the tuition charge and other costs of attendance. The aid program is focused to measure the dollar difference between the cost of attendance and the amount of money the family can contribute toward the cost. This gap is called financial need. Most financial assistance is awarded on the basis of need.

There are four basic forms of financial aid: scholarships, grants, loans, and student employment. *Scholarships* are based on academic achievement and need not be repaid; most have financial need as a criterion for eligibility. *Grants* are based on financial need and a minimum progress of twelve credit hours per semester; they do not require repayment. *Loans* are borrowed money and are repayable at low interest rates after the student ceases to be enrolled. *Employment* provides money for books and personal expenses, with funds disbursed as the student earns them at an hourly rate. Lehigh offers all four forms of aid.

Additional sources of aid are the federal government, state agencies, employers, and various clubs, churches, fraternal organizations, and foundations. High school guidance counselors may be able to provide information on local aid programs. Students are expected to be enterprising enought to seek out and apply for all possible kinds of outside financial assistance. The federal Pell (Basic) Grant program and state grant programs are important sources of aid. Students are required to take maximum advantage of outside sources so that Lehigh aid funds can be spread farther and student borrowing can be kept at a reasonable level.

Application Procedures

Families of freshmen desiring financial aid file a Financial Aid Form (FAF) with the College Scholarship Service (CSS) between January 1 and 31 of the student's senior year in high school. Forms are normally available in guidance offices in November. Procedures for early-decision applicants are outlined later.

The Financial Aid Form is a two-sided document. Side I is used for Pell (Basic) Grant and state grant review (except for Pennsylvania residents) and provides the basic data needed to determine federal and state eligibility. Side II requests additional information that is *required* by Lehigh. Pennsylvania residents are advised to use their Pennsylvania Higher Education Assistance Agency (PHEAA) application for requesting Pell Grant consideration.

All applicants should request that the College Scholarship Service send a copy of the application form to Lehigh. The Lehigh code number is 2365. Applicants also should have the CSS send the information to both the Pell Grant program and the state scholarship agency (where appropriate). If the student is granted aid from Lehigh for 1983-84, a signed copy of the parents' 1982 federal income tax return, Form 1040 with schedules, must accompany the acceptance. If possible, the tax return should be sent as soon as prepared to help with the review of the FAF. Aid awards are not final until the FAF and Form 1040 are cross-checked. Award adjustments are made where differences in income and assets exist.

Students of divorced or separated parents are asked to file an additional form. The applicant and the parent with whom the student resides (i.e., the custodial parent) complete the FAF. If that parent is remarried, the

stepparent information also must be included. The other (non-custodial) parent is asked to complete a separate form—the Divorced Separated Parent's Statement. Lehigh requires the statement, and will mail it to the applicant soon after receiving the FAF.

Parents who are self-employed, or who own an income-producing farm, must file a Business or Farm Supplement, available from the Lehigh office of financial aid.

Only the FAF and forms for special situations are required of incoming freshmen. Requests for a particular type of grant cannot be considered. The submission of the Financial Aid Form establishes the student as an applicant for all forms of Lehigh aid as well as federal aid awarded by Lehigh—Supplemental Educational Opportunity Grants, National Direct Student Loans, and College Work-Study jobs. Pell Grants can be applied toward tuition and costs at Lehigh, but the grants are awarded directly to the student by the federal government; Lehigh does not make the award. That is why those desiring aid must request that the College Scholarship Service send the FAF data to the Pell Grant processor.

Normally, the first selections for financial aid are made late in March, with notification to candidates as promptly as possible. The committee on financial aid endeavors to aid as many well-qualified students as funds will allow. In the competition for aid funds, need is the minimum criterion, with exceptional academic achievement and promise, commendable participation in activities outside the classroom, and good citizenship serving as important selection considerations. More students have been aided since the advent of the "package" concept of award-making in which a student receives a combination of nonrepayable aid (scholarship or grant) and self-help (loan and employment).

Each year a number of high school seniors apply for admission and financial aid under the university's early-decision program. Those students indicating an interest in early decision on their admission application receive an *early version* FAF from the financial aid office. This form is filed with the College Scholarship Service by November 15 of the year preceding planned matriculation at Lehigh. Financial aid decisions on completed applications are made by December 15. Early-decision candidates have no advantage in the competition for aid, and are required to file the regular FAF, between January 1 and 31, for purposes of federal and state aid. Pennsylvania residents file the PHEAA application, requesting Pell Grant consideration, prior to May 1.

It is necessary to reapply for financial aid for each subsequent year of study after the freshman year. Application forms are distributed and filing procedures explained at meetings held each February. Students are notified of these meetings, and prospective aid applicants arrange to attend.

Upperclassmen file the Financial Aid Form with the College Scholarship Service by April 1. A Lehigh application form must also be completed and returned to the university's financial aid office by April 1, accompanied by a signed copy of the parents' federal income tax return. An upperclassman is precluded from aid until the FAF, Lehigh application, and parents' 1040 income tax forms are submitted.

In addition, to receive any type of aid, a student must make normal academic progress each year by completing at least twelve credit hours of new course work each semester. Recipients of Lehigh grants and scholarships are expected to achieve at least the level of the all-university average (2.6). Students on academic or disciplinary probation are ineligible for scholarship aid during the period of their probation. Students not maintaining satisfactory progress, as defined by Lehigh, are ineligible for all forms of federal aid, including loans and employment.

Projecting the Family Contribution

Because of the expense of higher education, many families find it desirable to assess their financial status.

A student's eligibility for financial aid is determined by analyzing the amount a family can be expected to contribute based on income, assets, family size, number in college, availability of veterans benefits, and other factors. The expected contribution is then subtracted from the cost of attendance to yield *financial need.*

A student's savings and expectation of summer earnings are considered part of the family contribution. Incoming freshmen are expected to contribute $800 from summer earnings. Rising sophomores are expected to contribute $1,000 minimally, juniors $1,100 and seniors $1,200. Higher contributions are expected from students who have exceptional summer employment opportunities.

In general, a student might be expected to have some financial need when the family's annual income and number of tax dependents (usually children) are as follows:

with one child at home	$36,000
with two children at home	$40,000
with three children at home	$43,000
with four children at home	$46,000

In all cases, the figure is for income before taxes and deductions, allowing for normal savings and home equity. The above figures are for families with one child attending college. When more than one child is in college, the likelihood of a determination of need for financial aid is increased. In some instances, families with incomes as high as $60,000 are able to establish financial need if, for example, they have three children, all of whom are enrolled in independent universities.

Sources of University Aid

Several forms of university-funded assistance, based on need and merit, are available.

Trustee scholarships. These are awarded covering the tuition charges in whole or in part. Funds are budgeted from general income.

Supported scholarships. Individuals, foundations, and corporations provide these funds through contributions.

Endowed scholarships. Income from investments makes these scholarships possible. The university has 180 such funds, half of which are for general, unrestricted use. Most of the others are restricted by curriculum or geographic location.

Merit scholarships. The Annual Fund, to which alumni, friends, and parents make contributions, supports these scholarships. The National Merit Scholarship Corporation conducts the competition. Merit finalists listing Lehigh as their first choice are considered. The individual stipend is based on need, and is adjusted annually according to the financial status of the family.

Athletic awards. More emphasis on nonacademic attainments is given when candidates for these awards are evaluated. Alumni Student Grants (ASGs), also supported by the Annual Fund, are awarded on the basis of need to student athletes recommended by the department of intercollegiate athletics and recreation. ASG recipients refile the Financial Aid Form annually to determine the amount of their grant eligibility. Continued participation in the intercollegiate sport for which the grant was awarded is a prerequisite for renewal.

Presidential prizes. Ten incoming freshmen receive these awards annually. The $4,000 prizes are granted irrespective of need. A sum of $500 is applicable each semester towards tuition costs. Students receiving these prizes must maintain a B (3.0) average or better for continuation of the award.

Lehigh loans. Need and merit are the bases of loans. The maximum indebtedness that any student may incur generally does not exceed half the total tuition obligation. Each student qualifying for a loan signs a note, endorsed by parents. Repayment begins three months after graduation or withdrawal, until the loan plus interest is repaid. Repayment schedules are arranged by the bursar's office. Currently, the minimum monthly payment is $50 plus interest. Interest is at the rate of nine percent from the beginning of the repayment period.

Loan-cancellation awards. This unique Lehigh award is used as an aid alternative for students whose academic

average is not sufficiently competitive for scholarship consideration. L-C begins as a loan, with the same terms as Lehigh loans. A specified average must be earned during the period of this award for the loan to be cancelled and replaced by a scholarship. If not cancelled, the loan is repayable according to the terms for Lehigh loans.

Availability of Jobs

The office of financial aid provides listings of jobs for those students who have received aid in the form of a work-study job. Those selected check the job list as soon as they know their academic schedules. Work-study jobs pay U.S. minimum wage.

As a supplementary service, the office posts many on-campus and off-campus jobs. These jobs are open to all interested students, but students must take the initiative in applying for them. The university libraries, the department of intercollegiate athletics and recreation, residence halls operations, food service, and many other campus offices employ students on a part-time basis.

Aid recipients are cautioned that they probably cannot earn more than $100 in an outside job without becoming "over-awarded"—meaning that the sum of all resources exceeds computed need. "Over-award" status can jeopardize other portions of an aid package.

Aid From The Government

Students who apply for Lehigh-funded aid are screened automatically by the university for three aid programs sponsored by the U.S. Department of Education.

Each year Lehigh applies for funding for these programs and the number of possible awards is determined by the amount of money the federal government grants to Lehigh. The programs include the following:

Supplemental Educational Opportunity Grants. The SEOG program is designed for students of great financial need. Grants ranging from $200 to $2,000 per annum are available for four years of undergraduate study. Funds are limited.

National Direct Student Loans. The NDSL program enables the university to lend up to $1,500 per year, or $6,000 for four years. Repayment is made in quarterly installments beginning between the sixth and ninth month following graduation or withdrawal. Up to ten years may be allowed to pay back the loan. During the repayment period, five percent interest is charged on the unpaid balance of the loan principal.

No payments are required for up to three years while serving in the U.S. armed forces, the Peace Corps, or Volunteers in Service to America (VISTA). The bursar's office can explain loan cancellation provisions that affect some borrowers who become teachers; only those who teach in federally designated schools in poverty areas or who teach the mentally or physically handicapped qualify.

Recipients of NDSL assistance, who also apply for Guaranteed Student Loans (see following section) cannot combine loans exceeding $3,500 for the freshman year.

College Work-Study. The CW-S program assists students by subsidizing the wages they earn in campus jobs. Participating students may work up to twenty hours per week, with total earnings determined by computed need limits.

Other Governmental Assistance

Several other forms of financial assistance are available from federal and state sources. Among them are the following:

Pell Grant. Students apply directly to the federal government for the Pell Grant program. It provides nonrepayable aid. Pell Grants for the 1982-83 academic year ranged up to $1,800. To apply, a student requests that the family Financial Aid Form be sent by the College Scholarship Service to the Pell Grant processor. The Pennsylvania Higher Education Assistance Agency state grant application may also be used to apply for a Pell Grant and this is recommended to the commonwealth's residents to avoid delay in determining the student's state grant eligibility.

ROTC scholarships. The departments of military science and aerospace studies award to selected students scholarships that provide payment for tuition, books, and other educational fees as well as $100 per month. Recipients incur an obligation to serve as a commissioned officer in the Army or Air Force.

State grant programs. Several states offer financial help to students who apply directly to the state for aid. High school guidance personnel can provide information on application procedures. Some states, notably New York and New Jersey, do not allow state grants to be used in other states.

Students living in Pennsylvania were eligible for a grant-in-aid ranging up to $1,500 in 1982-83. Lehigh students also have received grants from Connecticut, Maryland, Massachusetts, and Rhode Island. Students from Delaware, Ohio, and West Virginia are eligible to bring state grants to Lehigh.

The university expects students to apply for state grants so that the needs of more students can be met. Failure to apply for state aid could jeopardize a student's eligibility for renewal of university-funded aid.

Guaranteed Student Loans. GSL programs exist in most states and allow students to borrow between $1,000 and $2,500 annually up to a maximum of $12,500 for a five-year undergraduate program. There is currently a five percent loan origination fee, which effectively reduces to $2,375 a loan request of $2,500. Students apply to a participating bank or other type of lending institution. It is necessary to retain the same lender for all undergraduate and graduate GSL.

Loans are repayable in monthly installments commencing six months after the student ends study at least half-time. Interest is currently nine percent per annum and is federally subsidized up to the start of repayment.

Borrowers do not have to make payment for up to three years while serving in the armed forces, Peace Corps, or in full-time volunteer programs conducted by ACTION. In addition, deferment is available any time the borrower returns to full-time study in approved programs. A single deferment for a period of not more than one year is also provided for students who are unable to find full-time employment.

The university recommends the GSL as part of most aid packages, reserving National Direct Student Loans and university tuition loans for those unable to find a lender.

Parent Loans. In the Parent Loan for Undergraduate Students (PLUS) program, parents borrow up to $3,000 per year for each dependent child enrolled full-time as an undergraduate student. Repayment, in monthly installments, begins sixty days after disbursement. The interest rate for PLUS is 12 percent, as of January, 1983. Lenders currently participating in the GSL program customarily participate in PLUS as well.

Checklist for Financial Aid

There are many steps involved in obtaining financial aid. The following checklist is provided in the hope that it will prove helpful to those desiring financial aid. The section applies, except as noted, to incoming freshmen and to students transferring to Lehigh undergraduate programs from other colleges and universities.

1. (freshmen only) Take the Scholastic Aptitude Test (SAT) required of every entering freshman for admission and for financial aid selection.

2. Submit an application for admission. Aid requests will not be reviewed until admission decisions are made.

3. (transfers only) Submit the Lehigh *Application for Undergraduate Financial Aid*. Be sure to complete all questions. Also, have your previous college(s) complete and forward the *Financial Aid Transcript*.

1. Submit the *Financial Aid Form* available from high schools and colleges. The form should be completed by parents and applicants and submitted to the College Scholarship Service, List Lehigh University, CSS *code* 2365, in item 41, and answer yes to questions 43 and 44, to ensure both university and Pell Grant consideration.

5. Submit a state grant application, particularly if you are a resident of Pennsylvania, Ohio, Massachusetts, Connecticut, Rhode Island, Maryland, Delaware, Vermont or West Virginia.

6. Submit signed copies of the latest IRS form 1040, with schedules, filed by student and parents. The 1982 tax return is required for the 1983-84 academic year, while the 1983 return will be required for consideration of financial aid in the 1984-85 academic year.

7. Check to be sure your social security number is correctly listed on all forms and on your application for admission. If you do not have a number, apply for one and notify Lehigh as soon as it is received.

For Enrolled Students

1. Submit to the office of financial aid the application for undergraduate financial aid by April 1 preceding the fall semester in which aid is desired. The application and other required forms will be distributed during February.

2. Follow steps 4 through 7 in the Checklist above, but not steps 1 to 3.

Campus Accommodations

Approximately eighty percent of all undergraduate men and women are in residence in on-campus facilities. These take the form of residence halls, apartments, suites in a multi-story building, or residence in fraternity houses or sorority units. Some students choose from a limited number of university-operated facilities located near the campus or in the community. Information about physical facilities may be found in Section VI.

Residence Halls

More than half of Lehigh undergraduates live in university residence halls. The university has twelve principal residence halls for undergraduate men and women. Most rooms are designed for two students, but a limited number of single, triple, or suite arrangements, and apartment units, are available.

When a candidate accepts an offer of admission to the freshman class, the candidate is sent a Room and Board Application-Contact. Those desiring accommodations in the residence halls must return this application-contract promptly. Priority of assignment is based on date of receipt of this application. A nonrefundable advance deposit of $100 must accompany the application and will be credited to the fall semester room charges. Normally, freshman room assignments are made in early August by the residence operations office.

Currently, the demand for upperclass campus housing exceeds the supply by approximately ten percent. For the duration of this imbalance, the University Forum has approved the use of a lottery to provide for fair and equitable distribution of available housing among upperclass students. The lottery is scheduled early in the spring semester. Those students who are guaranteed housing pay a $100 deposit to hold the space for the following academic year.

The university reserves the right to void a residence hall contract in the event a student's course load falls below the full-time credit requirements.

Each student in the traditional residence halls is provided with a bed, mattress, chest of drawers, desk and chair. Residents supply such personal items as pillows, wastebaskets, quilts, ashtrays, clocks, and radios. Most residents supply their own desk lamp. Students may supply their own bed linen and towels and make their own arrangements to have these laundered, or they may subscribe to a linen service that provides clean bed linen and towels each week. A coin-operated laundry service for student use is available in close proximity to each residence hall.

Residents are held responsible for damage done to their rooms or any other part of the residence halls.

The university is not responsible for the loss or destruction of any student property whether such losses occur in the residence halls, lockers, classrooms, etc. The safekeeping of student property is the responsibility of each individual student and no reimbursement from the university can be expected for the loss of such property. Insurance protection, if desired, may be obtained from an insurance broker or agent.

Information on off-campus housing may be secured from the residence operations office.

Fraternities and Sororities

The university has one of the strongest fraternity systems in the country. The continued strength of this system is the result of the many individual and group efforts on the part of the Interfraternity Council, the Fraternity Management Association, the Fraternity Alumni Council and the office of the dean of students to improve the climate and consciousness of fraternity life through pledging, leadership, social, and educational programs.

In 1976, chapters of three national sororities were installed. All are housed in an apartment complex in Saucon Valley. Delta Gamma was installed in 1982 and occupies an apartment building just east of the campus.

Fraternity and sorority living provides a desirable alternative to other forms of student residence at Lehigh. It provides students with a community living experience of a liberal but close-knit nature where they can participate on a group level as well as individually.

On the smallest scale exists the community within each house, a community which relies upon group-oriented and group-determined goals for its members, whether these goals are academic pursuit, athletic achievement, social participation, campus or greater community involvement, or even total individual freedom. The second community involves the fraternity and sorority systems themselves.

Twenty-six of the thirty-one national Greek-letter fraternities are located on campus in Sayre Park.

The fraternity park is a residential community in which each fraternity is part of a whole. The fraternities as diversified units participate together in planning and organizing social and community projects as well as in governance of the entire fraternity-sorority system. The third community is the university as a whole, of which the fraternity system is an integral and active part.

Fraternity and sorority life provides an avenue of responsibility that has no equal on campus. Students manage their own houses in business affairs and in planning activities as well as in determining social codes and in planning meal programs and living arrangements.

Fraternities, all nationally affiliated, include the following: Alpha Chi Rho, Alpha Epsilon Pi, Alpha Sigma Phi, Alpha Tau Omega, Beta Theta Pi, Chi Phi, Chi Psi, Delta Chi, Delta Phi, Delta Sigma Phi, Delta Upsilon, Kappa Alpha, Kappa Sigma, Lambda Chi Alpha, Phi Delta Theta, Phi Gamma Delta, Phi Kappa Theta, Phi Sigma Kappa, Pi Kappa Alpha, Pi Lambda Phi, Psi Upsilon, Sigma Alpha Mu, Sigma Chi, Sigma Nu, Sigma Phi, Sigma Phi Epsilon, Tau Epsilon Phi, Theta Chi, Theta Delta Chi, Theta Xi, and Zeta Psi.

The sororities include Alpha Gamma Delta, Alpha Phi, Delta Gamma, and Gamma Phi Beta.

The University Forum

The Lehigh University Forum is a unique deliberative body whose purpose is to promote the welfare of the university and attainment of a true sense of community by bringing into discourse students, faculty, and administration.

Its membership includes elected representatives of the student body and of the faculty, and members of the administration (including the president, provost, and vice president for student affairs).

Four Forum representatives—two students and two faculty members—attend meetings of the board of trustees. Assured of access to the information upon which administrative decisions are based and free to inquire into any aspect of university operations, the Forum affords faculty and students a voice in university affairs equaled at few institutions.

The Forum has been particularly effective in policy formation in the following areas: 1. extracurricular activities and social life; 2. planning that involves special educational opportunities; 3. the academic environment; 4. long-range planning and budget; and 5. appointments at the level of dean or higher.

Four Forum committees—academic environment; administration; campus life; and priorities, planning and development—are each jointly headed by a faculty member and a student. Numerous subcommittees work on specific issues, allowing Forum members either to work on a broad range of topics or to concentrate on particular aspects of university life they find most important. Many non-Forum students also work actively on subcommittees, and in some cases serve as chairmen. This participation provides valuable background and experience for later candidacy to the Forum or other elective positions.

The Forum also appoints student members to certain standing committees of the faculty and certain ad-hoc university committees when invited.

All meetings of the Forum are open to the university community, with the right to address the Forum provided to any person desiring to do so. The Forum office is located in the University Center, and students are invited to come in to discuss any aspect of university government.

Student Health Services

The university offers health services to all students, undergraduate and graduate, full and part-time, resident, and commuting students. Emergency care is available to staff and faculty.

The health services offices are located in Johnson Hall. The clinic hours in the fall and spring terms are 9 A.M. to 6 P.M., Monday through Friday, and 9:30 A.M. to noon on Saturday. During vacation periods and summer, hours are 8:30 A.M. to noon, and 1 P.M. to 5 P.M. Monday through Friday; there are no Saturday clinic hours in the summer.

The outpatient department includes the medical clinic, minor surgical clinic, allergy clinic, and gynecological service. The emergency room, staffed by registered nurses with physicians on call, is open twenty-four hours daily during the academic year.

Inpatient care is available in the hospital unit for all students eligible to use the health services facilities. Registered nurses are in attendance with a physician on call at all times. No major surgery is performed at the health services offices. Critically ill individuals are usually transferred to a general hospital.

When medically indicated, referrals are made to the physical therapy service, which is supervised by a registered therapist and located as part of the health services suite.

Routine clinical studies are done in the health services laboratory from 8:30 A.M. to 1:30 P.M.

Physical examinations are required prior to a student's arrival on campus. Following enrollment, additional examinations are provided by the health center for students participating in intercollegiate athletic programs, and when required for graduate school or scholarship programs. The health service does not provide examinations for military, insurance or employment purposes.

There is no charge for most of the care provided, whether in-patient or out-patient. Some exceptions are as follows: referrals to physicians, hospitals, or other medical facilities outside the student health center, medications not carried by the health center and for which prescriptions need to be given, and certain biologicals, such as flu vaccine.

A relatively low-cost university-sponsored plan is available. Expenses covered include costs for several services are not available at health services, such as X-rays, certain laboratory studies, consultant fees, and medications not stocked by health services. Hospital expenses are also covered. Students are urged to check with their parents regarding existing insurance coverage and to consider purchasing the university-sponsored plan if they are not adequately covered.

A health service brochure is distributed to all entering freshmen and is available through the health services offices to all other students. This brochure describes in more detail the policies and program of health service.

Religious Activities

The religious program is under the general supervision of the university chaplain. The chaplain also provides for Protestant chapel services, broadly based and ecumenical in form, varying from the traditional to the informal and innovative. Some services feature the university choir; others, folk music. Roman Catholic masses are arranged by the Newman Association Center chaplain.

Protestant and Roman Catholic service schedules are announced at the beginning of the year. Jewish services are available at the nearby Jewish Community Center. Attendance at all religious services is voluntary. The university is nondenominational.

The chaplain works with representatives from campus religious groups of all faiths and jointly sponsors a variety of programs together with those organizations. The chaplain's office has sponsored, in addition, luncheon programs and a film series, both with discussions; talks by religious leaders and faculty members; and multi-media presentations. The programs are open to all students.

The Newman Association carries on a program among Catholic students under the guidance of a priest. The association has its own building on campus.

The Hillel Foundation supports a program for Jewish students including a newly opened Hillel House as a focus of activity.

Protestant students have a variety of fellowship programs available to them, both on campus through the Lehigh Christian Fellowship and off campus with the various churches nearby.

Student Organizations

Student organizations and extracurricular activities embrace a wide range of activities. There is a radio station (with newly increased power), a twice-weekly student-run newspaper, a dramatic club, and many other opportunities for participation. Course societies promote intellectual interests in various fields of study and develop professional spirit among students.

Interest and hobby groups include art, ballet, band, chess, camera, computer, languages, rugby, sailing, skiing, boxing, judo, model railroading, political clubs, fencing, and waterpolo. These are described in the *Lehigh Handbook*, which is given to every student every year.

Volunteer Services

Varied opportunities for student expression of social responsibility exist through programs sponsored by the

Lehigh University Volunteers (LUV). Typically, more than 200 students participate in volunteer-service efforts in the Lehigh Valley area in a range of service programs. LUV is governed by a board composed of coordinators of its various projects.

Most of the volunteer work is done in cooperation with community agencies or schools. Some of the projects include tutorial programs in public and private schools, assistance in several local hospitals, Big Brothers, companionship and group work with children and adults in residential mental health treatment facilities, aid to the elderly in institutions and at home, blood assurance, and individual and short-term efforts.

LUV's office is located in the University Center.

Guide to Academic Rules and Regulations

The university, like the rest of society, has adopted over the years numerous rules and regulations. Some of the principal rules and regulations are given here so that currently enrolled and potential undergraduates and graduate students will be apprised of what is expected of them, and what they can expect of the university.

The two principal sections that follow concern academic regulations and those affecting general behavior. Additional regulations can be found in the *Lehigh Handbook*, and there is a comprehensive statement of all policy in the publication *Procedures, Regulations and Requirements (PR & R)*. All students are given a *Handbook* at the beginning of the fall semester; *PR & R* is available in the university libraries and in departmental and administrative offices.

Eligibility for Degree

In order to be graduated, a candidate for a baccalaureate degree must achieve a minimum cumulative average of 1.70.

To be eligible for a degree, a student must not only have completed all of the scholastic requirements for the degree, but also must have paid all university fees, and in addition all bills for the rental of rooms in the residence halls or in other university housing facilities. Payment also must have been made for damage to university property or equipment, or for any other indebtedness for scholarship loans or for loans from trust funds administered by the university.

Responsibility for meeting requirements. A student is responsible for consulting with the academic adviser or department chairperson, prior to the senior year, to ascertain scholastic eligibility for the degree for which this student desires to qualify and to determine that all program and credit hours requirements will be met.

Final date for completion of requirements. For graduation, all requirements, scholastic and financial, must have been satisfied prior to the graduation exercises.

Notice of Candidacy for Degree

Candidates for graduation on University Day in May or June file with the registrar on or before March 1 a written notice of candidacy for the degree; candidates for graduation in January file a notice of candidacy on or before December 1; candidates for graduation on Founder's Day, the second Sunday in October, file a notice of candidacy on or before September 1.

Failure to file such notice by such dates mentioned debars the candidate from receiving the degree at the ensuing graduation exercises. If a petition for late filing is granted, a fee is assessed.

Graduating Theses

Undergraduate theses, when required, are accompanied by drawings and diagrams, whenever the subjects need such illustration. The originals are kept by the university, as a part of the student's record, for future reference; but copies may be retained by students and may be published, provided permission has first been obtained from the faculty.

Credit and Grades

A semester hour of college work consists of one hour a week of lectures or classwork, or two or three hours of laboratory work per week (or laboratory work combined with classwork) for one semester. The normal assumption is that the student will be expected to do at least two hours of study in preparation for each hour of classwork. The term "semester hour" is used interchangeably with "credit hours."

Latest date for registration. No registration is accepted later than the tenth day of instruction in any semester.

Grading system. Final grades in courses are A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F. The key to grades is as follows: A—excellent; B—good; C—continuation competency, defined to mean that the student has achieved a level of proficiency such that the instructor believes that he or she is prepared to take any subsequent course that has this course as a prerequisite; D—unsatisfactory, but passing, defined to mean that the student has achieved a level of proficiency such that he can apply the course toward graduation, but in the estimate of the teacher he or she has not acquired adequate proficiency to perform satisfactorily in any subsequent course that has this course as a prerequisite; F—failure. Courses taken under the Pass-Fail system are graded P (passing) or F (failure); this system is described below.

A student who withdraws from a course during the first nine weeks of instruction will receive a grade of "W". All students who withdraw from a course after the above date will receive "WF" unless the committee on standing of students, for cause, allows a grade of "W" to be recorded.

A student officially withdrawn from the university after the above dates receives from each instructor a "WP" or "WF".

"Abs. (absent) indicates absence from a final examination.

The grade X is used to indicate absence from the final examination, when all other course requirements have been met. A grade of X, if the absence is for good cause (e.g., illness or other emergency), may be removed by a makeup examination for which a petition must be filed and approved.

The grade N is used to indicate that some course requirements have not been completed. In each case in which this grade is given, the course instructor provides written notification the department chairperson stating the name of the student receiving the grade, the reason for the incomplete work, the work to be done for the removal of the N grade, and the grade for the work already completed. The grade N is intended to be used only where the student established to the satisfaction of the instructor that there are extenuating circumstances.

In no case shall the grade N be used to report absence from a final examination when all other course requirements have been met.

A student who incurs an N grade in any course is required to complete the work at the earliest possible date, but not later than the last day of classes in the first full semester in residence (except summer) following receipt of the N grade. A student who incurs an N grade in any course and fails to remove the N grade within the specified period loses all equity in the course.

Failure to take the missed final examination at the first scheduled makeup period will result in the absent grade changing to an F.

The grade XN is used to indicate absence from the final examination and that some other course requirements have not been completed. In each case in which this grade is

given, the provisions apply. A student who incurs an "incomplete" in any course and fails to remove the "incomplete" within one semester, loses all equity in the course.

Pass-Fail Systems

Student Option System. This pass-fail grading option is intended to encourage student exploration of challenging courses that would normally be avoided for fear of depressing grade-point averages. It is intended particularly for exploration outside the major field.

Students should also avoid wasting this option on unsuitable courses, such as certain basic introductory courses having no college-level prerequisite or corequisite. The restrictions on the use of the system are listed below. Students who want to take particular courses pass-fail consult at the time of preregistration with both their curriculum directors or registration advisers and with the instructors offering the courses under consideration for guidance in this area.

Each curriculum director or registration adviser should consider the intent of this system and the demands of the particular curriculum, then formulate suitable guidelines to aid students in the intelligent use of this option. At the same time, instructors should be prepared to advise particular students as to the suitability of their particular courses for pass-fail option.

The restrictions on the use of the system are:

1. Before taking a course pass-fail, the student must have achieved sophomore standing, have declared a major, and must be in good academic standing.

2. No more than two courses may be taken pass-fail in any one semester. The student may take a maximum of six courses pass-fail per undergraduate career if engaged in a four-year program, or a maximum of eight courses per undergraduate career if pursuing a five-year, two-degree program.

3. No course may be taken pass-fail that satisfied any part of the graduation requirements for the student's current major except as provided by the designated course system.

4. A student must have the registration adviser's approval to take a course pass-fail. A student must designate the course(s) taken pass-fail by the tenth day of instruction in a regular semester or the fifth day of instruction in any summer session. Prior to this deadline, the student may transfer from pass-fail grading to regular grading or vice-versa without penalty. After this deadline, the student cannot transfer from regular grading to pass-fail grading, or vice-versa.

5. The instructor giving the course is not officially notified which of his students is taking the course pass-fail. Therefore, he reports a regular letter grade for the pass-fail students. The registrar will then record P for reported letter grades of A, B, C, and D; and F for a reported letter grade of F.

6. Under this system, the student surrenders equity to letter grades of A, B, C, or D if the course is passed. A passing grade is applied to the student's graduation requirements but it is not used in the computation of the cumulative average. An F grade shall be computed in the normal manner.

Designated Course System. There are some courses where pass-fail grading may be appropriate for the entire class when evaluation or grading of students may inhibit effective involvement. The restrictions on the use of this system of pass-fail grading are:

1. The course must be explicitly approved for pass-fail grading by the faculty following the procedures of *PR & R* 2.3.07. The committee on educational policy will evaluate requests for exclusive pass-fail grading on the basis of detailed syllabi, explicit statements regarding class hours and preparation hours, and an explanation of how grading will inhibit effective involvement.

2. A student may use only one course where grading is limited to pass-fail to satisfy requirements of the current major and only two such courses to satisfy graduation requirements.

3. A student who takes a course where grading is exclusively pass-fail must include this course within the provisions of restrictions 1. and 2. of the student option for pass-fail grading.

If approved by the faculty, courses may be designated as not available for pass-fail grading.

Grade Values and Probation

Effective August 31, 1983, the scholastic requirements for undergraduate students will be expressed in terms of the cumulative average—the weighted point average of all grades received in residence or at institutions specifically approved for grade transfer. The cumulative average is computed at the end of each semester and the second summer session. The following cumulative average requirements for good standing are in effect:

freshmen	1.50
sophomores	1.60
juniors and seniors	1.70

For purposes of computation, students who have completed fewer than 22 hours of course work shall be required to maintain a 1.50 average to remain in good standing. Students who have completed 22 hours but fewer than 52 hours shall be required to maintain a 1.60. Other students shall be required to maintain a 1.70—the average required for graduation—to remain in good standing.

Students who do not meet the above requirements will be placed on scholastic probation. Students who, regardless of their cumulative average, have failed more than eight hours of course work in any semester are also placed on scholastic probation.

While there are no hours requirements for good standing, certain categories of students (e.g., those on financial aid and those playing intercollegiate athletics) will be expected to maintain whatever hours are required for eligibility.

Removal from probation. Students are removed from probation at such time as they meet the standard listed above, effective at the end of any semester or the second summer session.

Dropped for poor scholarship. A student who makes a 2.2 average or better in the probationary semester but fails to meet the standards stipulated is continued on probation for another semester. A student who makes less than a 2.2 average in the probationary semester and fails to meet the standard stipulated in section 3.7.01, *PR & R*, is dropped for poor scholarship.

If a student goes on scholastic probation for the second but not consecutive term, a review by the committee on standing of students will determine whether the student will continue on scholastic probation or be dropped for poor scholarship.

Honors Opportunities

There are several kinds of honors awarded to undergraduates. Each department offers departmental honors to qualified students and each college offers an honors program as well; more information is contained in Section III.

Graduation honors. Degrees *with honors* are awarded by vote of the university faculty to those students who have attained an average of not less than 3.25 in their sophomore, junior and senior years of work at the university, and in not less than seventy-two hours of work graded A, B, C, D, or F.

Degrees *with high honors* are awarded by vote of the university faculty to those students who have an average of not less than 3.50 in their sophomore, junior and senior years of work at the university.

Degrees *with highest honors* are awarded by vote of the university faculty to those students who have an average of not less than 3.75 in their sophomore, junior and senior

years of work at the university.

Graduation honors are announced on University Day and on Founder's Day.

For special cases. Students who spend all or part of their sophomore, junior or senior years at another institution may qualify for graduation honors under the following conditions:

1. The student must have at least ninety credit hours of work at Lehigh and an average during the last six semesters in residence at Lehigh that qualified him or her for graduation honors. This average determines the highest category of graduation honors that is possible for the student to attain.

2. The student's average at the other institution when computed with the last four semesters at Lehigh must be such as still to qualify the student for graduation honors. This average may lower the over-all average of the student from one category of graduation honors to another one.

Graduation honors are published in the commencement program.

In all cases, it is required that each student have not less than forty-eight hours of work graded A, B, C, D, or F, including plus (+) or minus (-) designations.

In computing the averages of candidates for graduation honors, semester grades are weighted according to the number of credit hours in the course concerned.

Review-Consultation-Study Period

The Review-Consultation-Study (RCS) period is intended to provide a few days for informal academic work between the end of the formal instruction period and the beginning of the final examinations.

It is expected that students will use this period to consolidate their command of the material in their courses. Faculty members make themselves available to their students at announced times during the period; for example, at the hours when they ordinarily meet classes for instruction.

No quiz may be given during the eight-day period before examinations.

Good Citizenship

The university exists for the transmission of knowledge, the pursuit of truth, the development of students, and the general well-being of society. Free inquiry and free expression are indispensable to the attainment of these goals. All members of the academic community are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth.

Out of concern for individuality and respect for the privacy of all persons, the university does not impose a common morality on its members. Institutional existence, however, is a privilege granted by public trust, subject to the sanctions and responsibilities defined by the society of which the university is a part.

Furthermore, society generally provides legal canons, ethical mores, and conduct expectancies pertaining to individual and collective behavior. Thus, the university has the obligation to establish standards of conduct appropriate and applicable to the university community.

Lehigh accepts its responsibility as an institution within the broader social community. The standards of behavior expected of its members are those that the university regards as essential to its educational objectives and to community living.

In accordance with these purposes and objectives, disciplinary action will be taken when necessary to protect the academic integrity of the university and the welfare of its members. An emphasis on counseling and learning will accompany such action.

All members of the university community are subject to municipal, state and federal laws. Obviously the university cannot be a sanctuary for persons who violate these laws. Lehigh is concerned, however, about the rights of students as citizens (with equal protection under the law) and will direct them to legal counsel when necessary.

For just cause (relating to the educational purposes of the university), Lehigh reserves the right to review actions taken by civil authorities against its members. Although ordinarily Lehigh will not impose additional sanctions after criminal disposition of a case, it does have the obligation to introduce counseling and or disciplinary action of the person's conduct has interfered with the university's exercise of its educational objectives or responsibilities to its members.

Further, the university as a part of the community has an obligation to report serious crimes to civil authorities.

Lehigh relies primarily on general principles and statements of expectation for the guidance of conduct, and assumes that those admitted to the university community are capable of governing themselves accordingly. Specific regulations are kept to a reasonable minimum and are published in the *Lehigh Handbook*. These regulations govern academic honesty and social conduct (including drugs, alcoholic beverages, motor vehicles, etc.). Students are responsible for knowing the procedures, rules and regulations as published in the *Handbook*. Freshman residential students should note that permission is *not* granted to them to have motor vehicles on the campus.

Violations of the student conduct code are adjudicated by the committee on discipline, which operates under the principles of due process.

Policy on Dissent

Regarding dissent, the university faculty has a policy that emphasizes the responsibility of all members of the university community. The guidelines adopted broadly set forth acceptable forms of dissent on campus.

Generally, the policy on dissent provides the following:

1. Free inquiry and free expression, including the right to open dissent, are indispensable in achieving the goals of an academic community.

2. Coercive activities employed by individuals or groups either to repress legitimate dissent or to demonstrate dissent are a threat to the openness of the academic community and will be dealt with as an extremely serious matter.

3. Where physical coercion is employed or physical obstruction persists and the university is prevented from resolving the matter through its established disciplinary procedures, legal sanctions will be employed.

This statement provides that orderly and peaceful demonstrations on campus are not forbidden unless they interfere with legitimate university function. The authority for making the initial judgment in determining the permissible limits of protest rests with the president and counsel of an advisory committee consisting of four faculty members and four students.

Conduct that exceeds permissible limits will be met with university sanctions ranging in severity from admonition to expulsion, or in cases of aggravated or persistent violation of defined rights, with civil arrest and prosecution under an appropriate charge. Prime authority for discipline rests with the faculty and the university committee on discipline.

Nontraditional Students

Adults and other nontraditional students who desire access to regular university courses have a number of options available. They may apply for admission to an undergraduate or graduate degree program on a full or part-time basis.

If they need to take one or more courses for credit, but are not seeking a degree, they may seek admission to the General College Division on the undergraduate level or become associate graduate students on the graduate level.

Those who are not interested in earning credits can be placed in regular undergraduate courses on a noncredit basis by the office of continuing education. These continuing education students have the same rights and pay the same fees as auditing students, but they are not formally admitted to the university, and no official Lehigh transcript is created for them.

Registration Statistics

Undergraduate registration includes those in the College of Arts and Science, College of Business and Economics, and College of Engineering and Physical Sciences, as well as those in the General College Division who are not pursuing a specific degree program. In the breakdown by undergraduate classes, students are listed by the degree sought, even though the major subject is not always apparent.

Fall 1982	seniors	juniors	sopho-mores	fresh-men	total
arts	237	203	320	444	1204
arts / engineering	27	9	31	52	119
biochemistry	8	6	4		18
biology	14	5	3		22
business	216	237	206	190	849
chemical engineering	84	89	81		254
chemistry	9	5	1		15
civil engineering	49	42	34		125
computer engineering	25	35	46		106
computing / information science	22	24	17		63
electrical engineering	97	120	105		322
engineering	7	18	57	446	528
engineering physics	12	9	11		32
environmental science and resource management	4	4	2		10
fundamental science	1	2	2		5
geology	6	9	2		17
geophysics	3	1			4
industrial engineering	91	90	57	1	239
mechanical engineering	115	150	116	1	382
mechanics	2	2	1		5
metallurgy	25	20	8		53
statistics	1	2			3
total	1055	1082	1104	1134	4375

Spring 1982	seniors	juniors	sopho-mores	fresh-men	total
arts	261	216	269	348	1094
arts / engineering	28	13	19	51	111
biochemistry	10	8	2		20
biology	20	8	5		33
business	279	200	197	158	834
chemical engineering	119	79	76		274
chemistry	16	3	4		23
civil engineering	53	40	37		130
computer engineering	31	25	28		84
computing / information science	20	19	12	1	52
electrical engineering	126	86	97		309
engineering	3	8	89	380	480
engineering physics	15	10	8		33
environmental science and resource management	3	6		1	10
fundamental science	1	1	1		3
geology	7	6	4		17
geophysics	2	2			4
industrial engineering	77	87	78	1	243
mechanical engineering	161	95	140		396
mechanics	1	1	1		3
metallurgy	24	25	13		62
statistics	1		1		2
total	1258	938	1081	940	4217

Fall 1981	seniors	juniors	sopho-mores	fresh-men	total
arts	199	254	353	390	1196
arts / engineering	13	16	23	78	130
biochemistry	8	6	3		17
biology	12	12	4		28
business	243	217	190	173	823
chemical engineering	100	86	94	1	281
chemistry	14	7	5		26
civil engineering	51	46	42		139
civil engineering / geological science	1		1		2
computer engineering	30	24	29	1	84
computing / information science	11	23	5		39
electrical engineering	100	81	138		319
electrical engineering / engineering physics	3	1			4
engineering	4	3	75	468	550
engineering physics	9	9	12		30
environmental science and resource management	6	7			13
fundamental science	1	1	2		4
geology	7	1	2		10
geophysics	3	1			4
industrial engineering	61	91	73	1	226
mechanical engineering	140	117	136	1	394
mechanics	1	3			4
metallurgy	27	22	18		67
total	1044	1028	1205	1113	4390

Spring 1981	seniors	juniors	sopho-mores	fresh-men	total
arts and science	211	219	296	398	1124
arts engineering	14	14	18	41	87
biochemistry	13	6	4		23
biology	13	14	10		37
business	320	235	165	141	861
chemical engineering	110	99	67		276
chemistry	22	8	6		36
civil engineering	55	48	44		147
civil engineering / geological science	1				1
computer engineering	27	26	21		74
computing / information science	14	13	18	1	46
electrical engineering	94	99	78		271
electrical engineering / engineering physics	4	2	1		7
engineering	1	6	25	526	558
engineering physics	9	12	7		28
environmental science and resource management	6	3	5		14
fundamental science	3	1	2		6
geology	8	4	2	1	15
geophysics	2	1			3
industrial engineering	84	56	75		215
mechanical engineering	133	125	98	1	357
mechanics	1	1	2		4
metallurgy	38	19	20		77
psychology	1				1
total	1184	1011	964	1109	4268

Registration

	spring 1981	summer 1981	fall 1981	spring 1982	summer 1982	fall 1982
undergraduate	4296	762	4409	4234	734	4397
graduate students	1866	1170	1945	1932	1170	1915
special students	9		6	11		12
totals	6171	1932	6360	6177	1904	6324

Recipients of Honorary Degrees

Lehigh University awarded honorary degrees to the following individuals during the past two years. Where a year of graduation follows the name, the degree was from Lehigh.

Founder's Day, 1982

Dr. Peter Likins was installed as eleventh president of Lehigh University. No honorary degrees were awarded.

Commencement, 1982

Doctor of Science
Carolyn Eisele, professor emerita of mathematics, Hunter College, New York, N.Y.; she is a mathematician and one of the leading experts on the thought of the philosopher Charles S. Peirce.

Doctor of Science
Cyril Stanley Smith, professor emeritus of metallurgy, Massachusetts Institute of Technology; he is a noted research metallurgist and historian in his field.

Doctor of Laws
Reginald H. Jones, chairman of the board and chief executive officer, General Electric Co. (retired April 1, 1981); he is noted for his management style, which acknowledges a company as part of an interrelating web of employees, consumers, and others in the social environment.

Doctor of Laws
John B. O'Hara, '42, retired partner, Price, Waterhouse & Co., Philadelphia; he was partner in charge of his firm's Philadelphia office for seventeen years and has made many contributions to Lehigh, particularly the College of Business and Economics.

Doctor of Laws
John W. Oswald, president, The Pennsylvania State University, University Park; a botanist and plant pathologist, he has served as an academic administrator at several public institutions.

Founder's Day, 1981

Doctor of Engineering
Robert L. Ketter, Ph.D. '56, president, State University of New York at Buffalo; a civil engineer, he taught at Lehigh for two years before becoming professor and chairman of civil engineering at Buffalo. He has served as president of SUNY at Buffalo since 1970.

Doctor of Humane Letters
Margot Fonteyn Arias, prima ballerina and president, The Royal Academy, London; an internationally acclaimed prima ballerina, the Lehigh honorary degree is her first from an American institution.

Doctor of Laws
Donald H. Trautlein, chairman and chief executive officer, Bethlehem Steel Corp., Bethlehem; he has held his position since June 1, 1980, and unlike many of his predecessors has a background in accounting, not in engineering.

Commencement, 1981

Doctor of Engineering
Dexter F. Baker, '50, president and chief operating officer, Air Products and Chemicals, Inc., Trexlertown, Pa.; besides his activity as the head of a highly successful corporation, he is a Lehigh University trustee and has contributed to the enrichment of life at Lehigh in many ways.

Doctor of Engineering
Inge M. Lyse, professor emeritus of engineering, Norwegian Institute of Technology, Trondheim, Norway; he is an internationally known civil engineer whose expertise in the field of concrete construction led to more economical methods of using concrete.

Doctor of Humane Letters
The Rt. Rev. Lloyd E. Gressle, sixth bishop of the Episcopal Diocese of Bethlehem; he is widely known in the Lehigh Valley for his service to the community.

Doctor of Science
Frank Press, Institute Professor, Massachusetts Institute of Technology; he is a noted scientist and geologist and has served as a consultant on scientific matters to several presidents.

Doctor of Laws
Marina von Neumann Whitman, vice president and chief economist, General Motors Corp., New York; she has a distinguished career in academia as well as the business world, has published widely, and conducted a weekly television show for the Public Broadcasting Service.

Doctor of Laws
Col. Thomas E. Schaefer, '53, U.S.A.F., former defense and air attache at the American Embassy, Tehran, Iran; one of the 52 American hostages held by Iran, he is a much-decorated military officer.

III

Academic Programs in the Colleges

From its beginnings in 1865, the university's educational goal has been simple. As Dr. Peter Likins, president, phrased it shortly after his arrival in 1982, Lehigh affords "A liberal education for a useful life." Broadly, the university seeks to instill general life skills necessary to successful functioning in any career. These include the following:

- good oral and written communication skills;
- analytical and problem-solving abilities;
- interpersonal skills;
- "technological literacy"—the ability to integrate humanistic, social, and cultural values with technological utility.

This educational philosophy, supported by the three undergraduate colleges in the university, includes not only classroom offerings spanning the theoretical to the applied, but also extracurricular opportunities and support systems that enrich and reinforce intellectual and human growth.

Students are expected to take responsibility for their education, to seek out the varied educational opportunities at the university, and to use them fully. Help is available in each of the colleges, as well as through general university offices.

Advisement

Every undergraduate is assigned a faculty adviser. Until the major is declared, help is also available through the dean's office of the college in which the student is enrolled. When the major has been chosen, a faculty major from the major department will act as the academic adviser.

This adviser is one of the most valuable resources in the educational processes, not only to assist in making academic selections to match the student's particular background, interests, and future objectives, but also to identify program options, to work out an academic pace, and to develop career planning strategies. The adviser will help to identify other resources and support systems available at the university, such as The Learning Center, the counseling service and the office of career planning and and placement services.

Curriculum

Choice is a regular part of university life, and encompasses the determination of a college and major, the selection of courses each term, and the development of life goals and career options.

Many of these choices are academic in nature. The undergraduate curricula are flexible, designed to accommodate the changing interests and needs of students. Boundaries between colleges are as fluid as possible to provide many options in an educational program. For instance, students may take a bachelor of science (B.S.) degree in the College of Business and Economics or the College of Engineering and Physical Sciences with a minor in journalism, a division of the English department in the College of Arts and Science. There are five-year programs for which degrees are awarded in two colleges.

Transfers between undergraduate colleges is permitted but only *after the freshman year.* Students considering such a transfer must confer with their advisers to begin the process.

Curricular Flexibility

The Guide to Courses (Section V) describes academic offerings of the various departments. To provide additional flexibility and encourage student initiative and depth of investigation, the university has developed academic alternatives including the following:

Provisional Courses. Departments can introduce Provisional Courses temporarily within a semester, either experimentally or as a response to a contemporary social or scientific issue. If successful, a course may become part of

the regular curriculum. Such courses, identified with a 97 or 98 number (preceded by a 1, 2, or 3 indicating level) may sometimes be taken on a pass/fail basis. They may not be developed in time to be included with course listings but they are incorporated into the registrar's semester roster for a maximum of two semesters.

Independent Study. Juniors and seniors of ability who wish to concentrate in their chosen field can substitute no more than four or six credit hours of independent, unscheduled work each semester for an equal number of credit hours of elective work required for graduation. Students, in collaboration with the major adviser, with the advice of the departmental chairperson, and consent of the college dean, may structure such a project for study in any curriculum and most major study sequences.

Pass/Fail Option. Students have the opportunity to study in areas without concern for possible poor grades by electing a pass/fail option. Intended for exploration outside the major field, this option is open to those who are sophomores and above, in good standing, who have declared a major. The pass/fail option may not be used for major or minor subject credit toward graduation. Consultation with the adviser is suggested.(See page 29 for additional information.)

Graduate Courses. Qualified undergraduates who have maintained a 3.00 average in each of the prior two semesters may petition the Graduate School to register for 400-level courses for which they have the prerequisites. Undergraduates taking graduate courses may not carry a course load exceeding fifteen credit hours.

Cooperative College Program. Students can attend courses and programs offered by the member institutions of the Lehigh Valley Association of Independent Colleges (LVAIC). The other institutions are Allentown College of St. Francis de Sales, Cedar Crest College, Lafayette College, Moravian College, and Muhlenberg College. Consult the registrar for details.

Summer Opportunities. Remedial and advanced academic work can be taken in two summer sessions. Special programs and field work opportunities are available for intense in-depth experience. There are also short courses in a variety of subjects. A listing of planned summer programs is available in the spring.

Interdisciplinary Programs

The university's interdisciplinary programs are designed to cross the boundaries between colleges to accommodate new and developing fields as well as the interests of students. They include such programs as the following:

Afro-American Studies. A number of courses relevant to Afro-American Studies are available, such as: Engl 319, The Black in American Literature; Govt 352, Civil Rights; Hist 131, The Negro in America; SR 368, Urban Community; and Soc Psych 175, Competition and Cooperation in Modern Society. Students interested in work in Afro-American Studies may work out an interdisciplinary program with their advisers and college deans.

Law and Legal Institutions. This minor program involves eighteen credit hours of course work in the College of Arts and Science and the College of Business and Economics and is available to students enrolled in all three colleges.

Freshman Seminars. Interdisciplinary, problem-centered, three-credit-hour seminars for freshmen enrolled in all curricula are called Freshman Seminars. These serve as a General Studies option in the engineering and physical sciences curriculum, a preliminary distribution elective in the arts and science curriculum, and an arts option or free elective in the business and economics curriculum.

Science, Technology and Society Program (STS). Faculty from all three colleges explore the interrelationships between science and technological advancement and the quality of human life in the popular STS program.

Graduation Requirements

Students are expected to maintain regular progress toward the baccalaureate degree by carrying the "normal" course load—between fourteen and eighteen credit hours each semester. They may, however, wish to accelerate the pace toward graduation by using advanced placement credits, summer session study, course overloads during the regular semesters, and receiving credit for courses through examination.

Students in good academic standing earn their degrees by meeting the requirements of their specific degree curriculum as well as general university requirements. Waiver of program requirements is accomplished by a petition supported by the department and the committee on standing of students. Students should confer with their advisers on matters related to curriculum.

Students are expected to satisfy the credit-hour requirements of their chosen curriculum. Basic military science or aerospace studies credit hours are in addition to the credit hours specified in the curricula. Advanced military science or aerospace studies can be included within the normal program of each curriculum, but *not* within the minimum program for students in the College of Engineering and Physical Sciences. The maximum of six credit hours of advanced ROTC courses is permitted within the normal engineering program.

Honors Opportunities

Each department offers honors work adapted to its curriculum for students who wish to demonstrate unusual academic ability and interest in exploring a chosen field through independent study and research. The precise nature of the program for each student is determined by the academic major department, but may include:

Unscheduled work or independent study;
Participation in graduate (400-level) courses;
Honors thesis or project.

Qualified candidates should inform their academic advisers by the end of the junior year of their intention to work for departmental honors. The adviser will give the college and the registrar names of seniors working for departmental honors in particular majors. Names of those students attaining departmental honors are published in the commencement program.

Undergraduates in the College of Arts and Science may apply for acceptance into the College Scholar Program, which offers unique opportunities for those qualified to develop their critical faculties and intellectual interests. See page 11 for additional information. Only a handful of highly motivated students can achieve the College Scholar designation.

Experiential Learning

The accommodation of student interest extends beyond regular departmental offerings. Hands-on experiences in learning enrich classroom instruction. Each of the three colleges offers a number of such experiences for their undergraduates. Among them:

The Harrisburg Urban Semester. Undergraduates in all fields of study can spend a semester studying urban problems in Pennsylvania's capital city. They live and work with students from other participating Pennsylvania colleges and are supervised by The Harrisburg Urban Semester (THUS) faculty or faculty members from participating colleges.

Upon completion, students receive sixteen semester hours of credit.

The Washington Semester. Opportunity is available for several selected juniors or seniors to study in the nation's capital in cooperation with American University in Washington, D.C.

The students enroll at Lehigh but spend the semester in residence at American University with the students from

the participating colleges.

Should a student withdraw from either the Washington or Harrisburg program, the student will be held responsible for the costs incurred through the program. Costs will be calculated on the basis of the university's customary refund policy.

Institute of Architecture and Urban Studies. With Amherst, Brown, Colgate, Dartmouth, Duke, Middlebury, Mount Holyoke, Oberlin, Sarah Lawrence, Smith, Swarthmore, and Wesleyan, Lehigh participates in an educational program for architectural studies in New York City. Selected students from these colleges and universities spend their junior year at the institute, studying architecture and urban design with staff members from universities in New York City and internationally known professionals.

Study in foreign countries. To the extent that their courses of study permit it, students maintaining a "B" average or better are encouraged to consider spending one or two semesters of study in acceptable "junior-year abroad" programs or as regularly enrolled students in an institution in a foreign country. Students of foreign languages are especially encouraged to spend a period of study abroad.

Students must clear their study plans in advance with the registrar and departments concerned. Such advance clearance can assure transfer of credit.

Among the accepted programs are New York University in Spain, Smith College and Wayne State University in Germany, Sweet Briar College and Hamilton College in France, and Dickinson College at Bologna, Italy.

A one-semester program of study at University College in Buckingham, England, allows students from Lehigh to take courses associated with its well-known program in business and law and receive Lehigh credit. Lehigh also sponsors an exchange program with the University of Kent, the University of Manchester Institute of Science and Technology, and the University of York involving students and faculty from these institutions.

To emphasize further its interest in international study, the university has provided funds to cover transportation, tuition, and living expense stipend for a graduating senior desiring to study abroad.

The university, through the department of modern foreign languages and literature, offers scholarships for qualified students, on a competitive basis, to assist with travel costs.

Students interested in study abroad should consult G. Mark Ellis, associate dean, College of Arts and Science, Maginnes Hall.

Research initiates. Undergraduates who consider a career involving research are encouraged to investigate the possibility of becoming research initiates in their junior or senior years.

Research initiates are attached to specific research projects in progress, serving as assistants to advanced graduate students or to staff members. They assist in experiments, sit in on project conferences, and, if occasion permits, undertake small side investigations appropriate to their competence.

The research initiate may receive degree credit by registering for Independent Study for up to six credit hours per semester. In a few cases, a nominal stipend may be paid, and summer employment is occasionally available. The student should explore the possibility of becoming a research initiate with the curriculum adviser.

Inspection trips. The location of the university in the center of industrial activities of various types affords unusual opportunities for visits to manufacturing plants. Inspection trips to individual plants are a required part of specific courses in various engineering curricula. Written reports may be required. These trips are generally held during the senior year and involve an average expense of $25 to $50.

Apprentice teaching. The apprentice teaching program is designed to benefit students with junior or senior standing who wish to learn about teaching under the guidance and supervision of an experienced teacher. The apprentice receives instruction and experience in many aspects of the teaching process while working with the master teacher in a course taught by the master teacher.

Other experiential learning opportunities. Each of the three undergraduate colleges has developed informal programs designed to give students experience in their chosen fields—internships, cooperative programs with industry, and placement in work settings.

The College of Business and Economics, for instance, has designed a course, Mgt 311, in which students work with Lehigh University Management Assistance Counseling (LUMAC) for three academic credits. Students actually work with small businesses in the area. The many research and service centers on the campus provide a rich learning environment for students seeking realistic experience.

A variety of student professional organizations give students career-directed experiences as well as opportunities to interact with visiting scholars and professionals on real problems and issues.

Preparation for Graduate Work

Students planning to continue in graduate programs should take advantage of the flexibility in many undergraduate programs to design an upper-division curriculum that meets requirements in the anticipated graduate program.

The policy of the Graduate School provides as much flexibility as possible for students who wish to change to new but related fields of study after the baccalaureate degree. Students should consult with their previous program adviser and the department representative of the new field to establish an academic program that will remedy any deficiencies in background.

Five-Year and Related Programs

Bachelor / Master Degree

Of increasing interest to undergraduates are the two-degree, five-year programs that lead to both a bachelor and a master's degree. Because Lehigh's well-established graduate programs are closely integrated with the undergraduate programs, it is possible to consider programs leading to the arts/master of business administration degree and the engineering/master of science in materials program, among others. The fifth-year program in the School of Education enables those receiving a B.A. degree to accomplish professional teacher training and serve as salaried interns in public schools. After the completion of one year of full-time teaching, secondary teachers can receive the master of arts and elementary teachers can receive master of education degrees.

Many other five-year, graduate-level combination programs exist, and students are advised to consult with their adviser in planning such programs.

Arts / M.B.A. Program

Students in the College of Arts and Science may enroll in a special arts/master of business administration program by completing the 43 credit hours of courses listed below in the suggested sequence, while completing their major in one of the B.A. programs in the college during their first four years. At the end of this period, if they are admitted to the Graduate School, they may be granted their M.B.A. degree upon completion of an additional 39 hours of course work. This can usually be accomplished in two regular semesters and two summer sessions.

All courses listed below under "Other Required Courses" must have a grade of B minus or better in order to be credited towards the M.B.A. program.

The following comprise the required courses during the four years in the college:

required background courses

•	Eco 1	Economics (4)	
•	Math 41	BMSS Calculus (3)	**and**
•	Math 41	BMSS Calculus (3)	**or**
•	Math 21	Analytical Geometry & Calculus (4)	**and**
•	Math 22	Analytical Geometry and Calculus II (4)	
••	Acct 111	Computers in Business (3)	**or**
••	IE 18	Data Processing Fundamentals (3)	

other required courses

••	Eco 145	Statistical Method (3)	**or**
••	Math 231	Probability and Statistics (3)	
••	Acct 51	Essentials of Accounting (3)	
••	Acct 52	Essentials of Accounting (3)	
••	Eco 105	Microeconomic Analysis (3)	
••	Eco 119	Macroeconomic Analysis (3)	
•••	Acct 324	Cost Accounting (3)	
•••	Mgt 269	Management of Operations in Organizations (3)	
•••	Mgt 269	Quantitative Models—Conceptual (3)	
•••	Law 201	Business Law (3)	
•••	Eco 229	Money and Banking (3)	

• recommended in the freshman year
•• recommended in the sophomore year
••• junior standing required for this course

Note: Students who do not take Acctg 52 and Acctg 324 as undergraduates will be required to take Acctg 413 as part of their M.B.A. course work.

Five-Year, Two-Bachelor-Degree Programs

The university's five-year, two-degree programs enable a student to receive two bachelor degrees upon completion of five years of study.

The civil engineering and geological sciences program that affords two bachelor degrees, and the electrical engineering and engineering physics two-degree program are examples of programs in the College of Engineering and Physical Sciences.

Students who wish to declare a second major in another college or both a B.A. and a B.S. degree within the College of Arts and Science must have a minimum of thirty additional credit hours beyond the first degree credit-hour requirements in order to qualify for the second degree.

Most five-year, two-degree programs appear in the description of courses under Arts-Engineering and Five-Year Programs in Section V. It is possible to arrange for a dual bachelor degree program even after studying at Lehigh for some time. Engineering students, for example, who decide at any stage of study that they wish to meet the requirements for both the bachelor of arts and bachelor of science degree may complete the combined requirements in five years if the decision is made before the third year.

Arts-Engineering Option

The curriculum in Arts-Engineering is especially designed for students wanting a regular professional education in a field of engineering and also the opportunity to study broadly in a second field.

Arts-engineers fulfill all requirements for the professional engineering degree for which they are working. However, the first three years of science and engineering courses are scheduled over four years for the arts-engineer. During this period the arts-engineer is a student in the College of Arts and Science pursuing a bachelor of arts and bachelor of science major program.

In normal circumstances the student will complete work for a degree in the College of Arts and Science at the end of four years. The student transfers for the fifth year to the appropriate department of engineering, where he or she pursues a regular fourth year of science and engineering course work in the chosen field of engineering.

These arrangements make it difficult for an arts-engineer to qualify for the bachelor of science degree in the College of Engineering and Physical Sciences before meeting all requirements for the baccalaureate in the College of Arts and Science. In some instances it may be advisable to take the two degrees at the end of the fifth year. To qualify for both degrees, a student must submit for the second degree thirty credit hours in addition to the number required for the bachelor of science in engineering alone.

Arts-engineers working for the bachelor of arts automatically fulfill the engineering General Studies requirements while fulfilling the distribution requirements of the College of Arts and Science. Arts-engineers working towards the bachelor of science in biology, computing and information science, environmental science and resource management, geological sciences, and geophysics are advised to pay special attention to the engineering General Studies requirements, which must be met in time for the student to qualify for the B.S. in engineering.

Arts-engineers have the same opportunities for multiple majors and special interdisciplinary majors as are available to students working for the baccalaureate (B.S. or B.A. degree only) in the colleges.

Pattern rosters that show the normal combination of courses for the first four years of the arts-engineering curriculum are found on page 35.

College of Arts And Science

John W. Hunt, *dean*; G. Mark Ellis, *associate dean*; Bobb Carson, *associate dean* (effective August 15, 1983)

The College of Arts and Science offers several curricular options:

A four-year curriculum in arts and science, leading to the degree of *bachelor of arts*;

Four-year curricula in the fields of biology, computing and information science, environmental sciences and resource management, geological sciences, geophysics, and statistics, leading to the degree of *bachelor of science* in the designated field; and

A *five-year curriculum* in arts-engineering leading to a bachelor's degree from the College of Arts and Science and a bachelor of science degree in the student's field from the College of Engineering and Physical Sciences.

Students in all of these curricula must meet a requirement for freshman English. The normal requirement is Engl 1 and 2, 4, 6, 8 or 10. See Advanced Placement in Section II.

Specific requirements for many of the degree programs described in this section may be found in Section V.

Bachelor of Arts Degree

The curriculum in arts and science emphasizes a liberal education. It asks the student, in collaboration with the adviser, to select courses to satisfy three general categories, namely, distribution to insure breadth of education, a major field of concentration to provide depth, and free electives to provide breadth and depth to meet the student's needs.

Graduation Requirements

The bachelor of arts degree (B.A.) requires the completion of a minimum of 120 credit hours of collegiate work, apportioned to cover the distribution and concentration requirements. A cumulative average of 2.00 or better in the courses is required in the major program

and the completion of all general requirements apply to all candidates for baccalaureate degrees.

Distribution Requirements

There are two types of distribution requirements, preliminary and upperclass. The objective of the distribution requirements is to give an elementary knowledge of the fields of contemporary thought and to orient the student to the world of man and nature. Preliminary requirements also allow students to experience each of the college's distribution areas before a major field of concentration must be chosen.

The student has a wide choice of offerings from which to select courses to fulfill distribution requirements, and should discuss these with the faculty adviser prior to preregistration each semester.

Major Subjects

The college offers the following major subjects.

Bachelor of Arts Degree

Humanities. Architecture; Art—Art History and Studio Art; Classics—Classics and Classical Civilization; English; Journalism—Journalism and Science Writing; Modern Foreign Languages—French, German and Spanish; Music; Philosophy; Religion Studies; Theater.

Social Sciences. American Studies; Economics; Foreign Careers; Government; History; International Relations; Social Relations (includes anthropology, social psychology, and sociology); Urban Studies.

Mathematics and Natural Science. Applied Science; Biology; Chemistry; Geology; Mathematics; Natural Science; Physics; Predental Science; Premedical Science; Psychology.

Bachelor of Science Degree

Biology; Computing and Informational Science; Environmental Sciences and Resource Management; Geological Science; Geophysics; Statistics.

Major Field of Concentration

By the end of the sophomore year, each student in the curriculum of arts and science selects some sequence of studies as a major field of concentration. A major consists of at least twelve hours of advanced work in the field chosen. Including preliminary college work, the minimum number of hours constituting a major is 24.

The major field of concentration is designed to enable a student to master an area of knowledge so far as that is possible during the undergraduate years. In all fields, certain courses are prescribed, but merely passing courses will not satisfy the major requirements. A student must achieve a minimum 2.0 average in major courses.

Standard major sequences. The student may choose one of the standard major sequences. When a student selects one of these standard majors, the chairperson of the department offering the major or the director of a nondepartmental major becomes a student's major adviser and makes out the student's major program. The final responsibility for meeting both major and nonmajor requirements, however, rests with the student.

Special interdisciplinary majors. In addition to the standard major programs, specially structured interdisciplinary major sequences are possible.

For example, a student interested in a professional school of urban or regional planning might wish to structure a special major consisting primarily of courses in government and economics, or in economics and social relations.

Any student may, with the aid of faculty members chosen from the disciplines involved, work out an interdisciplinary major program to include not less than twenty-four hours of related course work, of which at least twelve hours shall consist of advanced courses. The program must be approved by the major advisers and the dean of the college.

Multiple majors. Some students choose to fulfill the requirements of more than one major sequence. A student initiates this by having separate major programs made out by different major advisers.

Because successful completion of only one major program is required for a baccalaureate degree, a student with more than one program is asked to designate one as the administrative major for preregistration purposes but is expected to maintain normal progress in fulfilling the requirements in both.

Students who wish to declare a second major in another college or both a B.A. and B.S. degree within the college must have a minimum of thirty additional credit hours beyond the first degree credit-hour requirements in order to qualify for the second degree.

Bachelor of Science Degree

Students desiring to major in the fields of biology, computing and information science, environmental sciences and resource management, geological sciences, geophysics, and statistics may elect to work for a bachelor of science degree (B.S.) This option is also open to arts-engineers desiring to major in one of these fields.

A student electing to work for the bachelor of science degree may have a strong preprofessional orientation and will take more courses in the major field of concentration than will another in the bachelor of arts (B.A.) program. In all other respects the student in a bachelor of science curriculum meets the same requirements as the student in the bachelor of arts program, except that the B.S. candidate is not asked to fulfill the same distribution requirements.

The bachelor of science distribution requirements in the College of Arts and Science consist of a minimum of thirty credit hours taken in courses outside the natural sciences and mathematics. Of these thirty credit hours, at least twelve credit hours must be taken in courses in the humanities, and at least twelve in the social sciences. The humanities and social science courses satisfying this distribution requirement are those approved by the faculty for this purpose and listed under the appropriate categories of the distribution requirements for the B.A. degree.

Preliminary Requirements

The preliminary requirements should normally be fulfilled by the end of the student's fourth semester of college work. However, when a student's academic program permits, they could be completed by the end of the third semester. Courses in mathematics, natural science, and modern foreign and classical languages may be used for either preliminary or upperclass requirements, based on the student's progress in the discipline. Preliminary courses are those numbered below 100.

At least one course from each of two subcategories in each of the first three distribution areas listed below, and either Option A or B of Area IV, are normally required by the end of the fourth semester.

Area I: Humanities
a. Classical and modern foreign languages
b. Literature (courses in English or American literature; Greek, Latin, or modern foreign literature in translation; or foreign literature courses at the third-year level or higher not involving conversation and composition)
c. Philosophy
d. Arts (architecture, fine arts, music, theater)
e. Religion studies
f. Interdisciplinary humanities courses

Area II: Social Sciences
a. Government; international relations
b. Psychology courses designated SS (social science) and

social psychology courses (taught in social relations)
c. Sociology and anthropology
d. History (including ancient history); archaeology
e. Economics
f. Urban studies, interdisciplinary social science courses

Area III: Mathematics and Natural Science
a. Mathematics, logic, computing and information science
b. Astronomy, biology, chemistry, geological sciences, physics, psychology courses designated NS (natural science), interdisciplinary natural science courses.

At least one science course taken to meet either the preliminary or upperclass distribution requirement in this area must include a laboratory.

Area IV: Foreign Language or Culture
Option A, foreign languages. Demonstration of foreign language ability at the intermediate level is required by successfully completing or otherwise obtaining Lehigh credit for the fourth semester, or beyond, in any foreign language at Lehigh, or completion of two semesters of any foreign language not offered for admission.
Option B, Foreign cultures and literature in translation. Two courses chosen from a list determined by the college and announced through the dean's office must be completed successfully.

Upperclass Requirements

To insure intellectual breadth in the progress towards the bachelor of arts degree, a student fulfills upperclass distribution requirements, normally after the major field has been selected.

These requirements consist of at least twenty credit hours in those two of the first three areas listed above (Area I: Humanities, Area II: Social Sciences, Area III: Mathematics and Natural Science) that do not include the student's major area of concentration. These twenty credit hours must be distributed so that each of the two distribution areas includes a minimum of two three-hour courses.

All of the courses in the humanities and social science distribution areas must be above the elementary level, except for courses in foreign and classical languages. All levels of courses are allowed in the mathematical and natural science distribution areas. No student may use a single course to fulfill both preliminary and upperclass distribution requirements or to fulfill two different categories within distribution requirements.

If a course is cross-listed (listed by more than one department), its preliminary or upperclass designation shall be the same in both departments.

A student's program, including the choice of distribution requirements, is not official until approved by the adviser.

Language Opportunities

Students are strongly urged to begin or continue the study of foreign languages and cultures by registering for courses offered by the department of modern foreign languages and literature or the department of classics. Students who are qualified are also encouraged to participate in approved study-abroad programs regardless of their major.

The principal purpose of foreign-language study is to develop means of perceiving and understanding a culture other than one's own. The ability to use a foreign language enables the student to communicate with those who are part of a foreign culture. Furthermore, in acquiring such ability, the student may sharpen knowledge and use of English.

Students who are planning on graduate study toward the doctor of philosophy degree are reminded that most graduate schools require Ph.D. candidates to demonstrate a reading knowledge of one or two foreign languages. Ability to use foreign languages is beneficial in many careers, such as law, journalism, commerce, industry, and government.

Minor Programs in the College

Certain departments, divisions, and programs in the College of Arts and Science afford an opportunity to minor in an additional field of concentration other than the major field.

A minor consists of at least fifteen credit hours; the specific content is determined in the department, division, or program concerned. A minor is optional and, if successfully completed, will be shown on the university transcript in the same manner as the major field of concentration. A 2.0 minimum grade-point average is required for courses in the minor.

If a minor program is not listed under the department desired, the student should consult the department chairperson.

It is the responsibility of students desiring a minor to initiate it no later than the beginning of the junior year by filing a minor program with the department, division, or program where it is offered. The student's major adviser keeps appropriate records.

Minors in the College of Arts and Science departments and programs are available for degree candidates in other colleges within the university, with approval of their college adviser.

Education Minor

The purpose of the education minor is to help undergraduates explore a career option in school teaching or other professional careers with elementary, secondary, or special education students. The minor may accelerate entry into a teaching career because appropriate credits from the minor may be applied toward completion of teacher certification credits for those admitted to Lehigh's graduate-level Teacher Intern Program.

The minor offers a systematic background of professional education experiences, coordinating practicum activities with theory courses designed to provide a foundation for future educational studies. Its focus is exploratory. No career decision is required but the minor is provided for those with a serious interest in considering the teaching profession.

The experiences of the minor are intended to enrich an individual's understanding of education as a central intellectual phenomenon of our culture and to provide self-understanding of one's own potential as an educator.

An undergraduate may take one or all of these courses during the junior and senior years with the approval of the adviser. Completion of the minor does not assure admission to the Teacher Intern Program to become a certified professional. However, if the student passes the screening process on the basis of previous work and interviews, he or she may enter the intern program with advanced standing toward certification.

The program coordinator is Alice D. Rinehart, department of instruction and curriculum, School of Education, 524 Brodhead Ave., adjoining the campus.

Fifteen credit hours are chosen from among the following courses for those in the education minor:

I&C 312	Classroom Practice (1) (must be taken concurrently with I&C 314)
I&C 314	Intern Seminar (2) (must be taken concurrently with I&C 312)
I&C 394A	Special Topics in Instruction and Curriculum: Child Development (3)
I&C 394B	Special Topics in Instruction and Curriculum: Youth in Society (3)
I&C 394C	Special Topics in Instruction and Curriculum: Introduction to Foundations of Education (3)
	Elective Education course (appropriate to student's objective (3)

East Asian Studies

The minor program in East Asian Studies affords undergraduates of any Lehigh college an opportunity to acquire a systematic knowledge of East Asia (China, Japan, Korea, and the Pacific). The program encompasses the rich historical and cultural heritage of the countries of East Asia, as well as their growing importance in world affairs

and their critical relationship to the national interests of the United States.

The minor program is intended as a complement to a student's major field of study, and it is flexible according to individual needs. Students are free to survey the field broadly or concentrate in a special area such as the Chinese language. The minor is composed of any five courses (15 credit hours minimum) in East Asian studies, chosen from an approved list in consultation with the program director. In addition, students are encouraged to avail themselves of a variety of extracurricular activities that are offered in East Asian Studies, such as special lectures and seminars, films, performances, and exhibits.

The over-all program is administered by the East Asian Studies Committee, an interdisciplinary body of faculty members with a special interest in the region. This committee oversees both the formal academic work within the program as well as the extracurricular activities sponsored at the university. It also cooperates with the East Asia Society, the Chinese Students Club, and other campus organizations involved in some aspect of East Asian Studies.

The following courses are regularly offered in the program and new ones are under development in Science, Technology and Society, comparative economics, East-West cultural perceptions, and various aspects of modern Japan.

For further information, consult Raymond F. Wylie, director, East Asian Studies Program, 208 Maginnes Hall.

East Asian Studies Courses

Chinese 1	Elementary Chinese I (4)
Chinese 2	Elementary Chinese II (4)
Chinese 11	Intermediate Chinese I (3)
Chinese 12	Intermediate Chinese II (3)
Engl 91	Asian Literature in Translation (3)
Govt 106	The Chinese Political System (3)
Hist 4	Chinese Civilization (3)
Hist 175	Modern China (3)
Hist 176	Topics in East Asian History (3)
IR 21	Modern East Asia (3)
IR 22	Contemporary East Asia (3)
IR 321	China in World Affairs (3)
MFL 171	Introduction to Chinese Culture (3)
RS 126	Buddhism (3)
RS 115	Religions of China (3)
SR 184	Cultures of the Pacific (3)

Interpersonal Behavior in Small Groups And Organizations

This minor has as its general focus the understanding of face-to-face interaction among human beings in small-group settings in a variety of organizational contexts. It will be relevant to students interested in personnel, the helping professions, group work, or any occupation requiring interpersonal skills in group settings.

The minor has both a cognitive and experiential learning dimension. Thus the student may become acquainted with the major theories, concepts, and issues concerning interpersonal behavior in social contexts and also with some of the tools, skills, and insights that promote growth and competence in social interaction. Experiential learning also includes training in techniques of naturalistic observation of social interaction in small groups and organizations.

These courses are not arranged in a sequence; that is, while they individually may put more stress on the cognitive or experiential dimension, none are prerequisites for any other. Thus students may select any course, subject to the prerequisites and requirements of the university and the department, as well as availability.

The coordinator is Robert E. Rosenwein, Price Hall.

Fifteen credit hours are chosen from among the following courses for the minor in Interpersonal Behavior:

Mgt 321	Organizational Behavior (laboratory sections only) (3)*
Psych 121	Encountering Self and Others (3)
SR 121	Social Psychology of Small Groups (3)
SR 151	Utopias and Alternative Communities (3)
SR 395	Methods of Observation (3)
SR 312	Interpersonal Behavior in Small Groups (3)

* Mgt 270 is a prerequisite for all management courses.

Italian Studies

This minor affords an opportunity to understand important contributions of the people of the Italian peninsula to western civilization from the period of antiquity to the present. The program is strongly oriented toward the cultural: art, archaeology, architecture, literature; this minor may be of interest to music students.

This minor allows for the study of Italian literature in the original as well as in translation. It requires the assimilation at the intermediate level of one of Europe's important languages, which is normally considered essential to advanced studies of the Renaissance.

The program also considers the present. Students taking this minor are brought up to date not only on European Italians but also on Italian-Americans. Courses in literature (in Italian and in translation) as well as in urban studies add a socio-political feature.

Courses are chosen in consultation with the program coordinator, John A. Van Eerde, Coppee Hall.

Fifteen credit hours are chosen from the following:

Art 115 or Arch 207	Italian Renaissance Art (3) Renaissance Architecture (3)
Clss 22	Roman History (3)
Clss 203	Archaeology of Italy (3)
Ital 11-12	Intermediate Italian I and II (6) (required of all minors)
Ital 171	Advanced Readings (3)
Latin 11-12	Intermediate Latin I and II (6)
US 326	The American Italian Community (3)

Jewish Studies

This program enables students of diverse backgrounds to become acquainted with the characteristic features of Jewish culture and religion: the distinctive story of the Jewish people, their trials and achievements, their formative influences on civilization, and their responses to other cultures and peoples.

A student may minor in Jewish Studies or take several courses in the field, including independent study. Study abroad, especially in Israel, offers wide opportunity for learning and enrichment and therefore is encouraged.

Colloquia for students and faculty are periodically held as adjunct to the Jewish Studies courses to provide resources outside the structure of the classroom and to offer a wider forum for sharing interests and expertise.

The program is designed to be of wide interest. A minor can be a broadening addition to various majors. Jewish Studies can serve as a coordinating area study of the interaction between various cultures, religions, and national communities and the Jewish culture, religion, and people. Again, attention to what is characteristic of the Jewish tradition can contribute to an understanding of other traditions.

Jewish Studies is relevant to various sociological and psychological questions (including majority-minority relations, prejudice and stereotyping, assimilation and pluralism) and many religious and philosophical issues (such as God, human moral responsibility, and evil and suffering).

Courses are chosen from several academic disciplines in consultation with the department of religion studies.

A minimum of fifteen credit hours is chosen from the following courses. (A maximum of six credit hours of Hebrew may be counted.)

Clss 241	Paganism and Christianity in the Roman Empire (3)
Engl 312	Jewish Literature (3)
US 328	The American Jewish Community (3)
Hebrew 1	Elementary Modern Hebrew I (3)
Hebrew 2	Elementary Modern Hebrew II (3)
Hebrew 11	Intermediate Modern Hebrew I (3)
Hebrew 12	Intermediate Modern Hebrew II (3)
Hist/RS 154	The Holocaust: History and Meaning (3)
IR 31	Middle East in World Affairs to 1945 (3)
IR 32	Middle East in World Affairs Since 1945 (3)
MFL 161	Cultural Mosaic of Modern Israel (3)
Phil 133	Medieval Philosophy (3)
RS 61	Judaism (3)
RS 107	The Islamic Tradition (3)
RS 109	Islam in the Modern World (3)
RS 111	The Hebrew Bible/Old Testament (3)
RS 151	The Jewish-Christian Encounter (3)
RS/Hist 154	The Holocaust: History and Meaning (3)
RS 163	Contemporary Theology (3)
RS 271	Special Topics (1-3)

Latin American Studies

The minor in Latin American Studies represents an opportunity to explore the language, literature, history, cultures, and socioeconomic problems of our neighbors to the south. It provides a perspective on the problems of other underdeveloped regions of the world, in contrast to most offerings in the humanities and social sciences that usually focus on the mainstream of western culture, notably the United States and Western Europe.

It is worth noting the importance of Latin American cultures in the future of the hemisphere. Latin America is the most rapidly growing part of the world, and by the year 2000 it is predicted that the area will have a population of 600 million, or twice that of Anglo-America. Several countries, especially Brazil and Mexico, are undergoing rapid industrial expansion. Consequently, besides the personal values to be derived from this curriculum, there are business, governmental, and related career possibilities.

The minor program represents fifteen credit hours, or five courses, chosen from economics, history, sociology and Spanish or Portuguese in discussion with the coordinator, Victor M. Valenzuela, Coppee Hall.

I. Required course (3 hours)
Span 152 Cultural Evolution of Latin America

II. Elective courses (12 hours) chosen from:

MFL 81	Brazil and Its Culture (3)
Eco 305	Economic Development of Latin America (3)
Hist 49-50	History of Latin America (3)
Hist 265	Mexico and the Caribbean (3)
Hist 266	Argentina, Brazil and Chile (3)
Hist 368	Seminar in Latin American History (3)
SR 367	Latin America in Change and Conflict (3)

courses in Latin American literature (6)

No more than six credit hours should be chosen from a given department. A proficiency level in Spanish and/or Portuguese is required, depending on the student's area of special interest.

Law and Legal Institutions

This program, based in the College of Arts and Science, is designed to foster interdisciplinary cooperation with the faculties of the other colleges in the university. The Law and Legal Institutions minor program is open to students from all three undergraduate colleges. Although the program may be of particular interest to some prelaw students, it should not be viewed as the preferred pattern for those hoping to attend law school.

The eighteen-credit-hour program stresses the systematic analysis of contemporary legal institutions, coupled with an examination of their historical antecedents, especially those in the Anglo-American common-law tradition. The program also exposes students to both public and private law, and to courses using the traditional case methods as well as those of the social sciences and philosophy.

Each student's minor program is a coherent combination of courses individually and jointly designed by the student and the program director. To avoid unnecessary confusion, students are urged to declare their minor in Law and Legal Institutions by the end of their sophomore year, in no event later than the last semester of their junior year.

Required preliminary courses (6 credit hours)

Phil 13	Practical Logic (3)
Law 11	Introduction to the Law (3)

Elective courses (nine credit hours required with at least one course in each category. Law 201 may not be included in the minor programs of students in the College of Business and Economics.)

Category I—Case Method

Govt 351	Constitutional Law (3)
Govt 352	Civil Rights (3—
Govt 354	Administrative Law (3)
Journ 122	Law of the Press (3)
Law 201	Business Law (3)

Phil 221 (Law 221) Sex Discrimination and the Law (3)

Category II—Non-Case Method

Clss 161	Roman Law (3)
Hist 357	English Constitutional and Legal History to 1783 (3)
Hist 358	American Constitutional and Legal History Since 1783 (3)
IR 361	International Law (3)
IR 362	International Law (3)
Phil 122	Philosophy of Law (3)

required advanced course (3)
Legal Research Special Topics (3)
This course is taken during the senior year. It aims at developing basic legal research skills and at using at least some of these skills in the execution of a research project focused upon an area of law that is of interest to the student. These projects are approved and supervised by a faculty member affiliated with the program and receive course credit in that faculty member's department.

For further information, consult the program director, J. Ralph Lindgren, Philosophy Building.

Russian Studies

The minor in Russian Studies is an interdisciplinary program designed to provide a broad range of study of Russian and the Soviet Union. It can be considered the beginning of a specialization in the area that can be continued in graduate school, or a useful area of concentration for certain careers after graduation (e.g., foreign service, governmental employment, business, foreign trade, etc.). The program may also be of general interest to nonspecialist students who wish merely to do focused work on the culture and society of the major country in the socialist world.

The minor in Russian Studies requires eighteen credit hours of formal course work, chosen in consultation with the program director, Donald D. Barry, department of government.

I. Required courses (15 hours)
six hours of college-level Russian based on the student's

level of competence; **or**
six hours of Russian literature in translation (6)

Govt 161	The Soviet Political System (3)
Hist 361	A History of Russia to 1855 (3) **or**
Hist 362	A History of Russia, 1855 to the Present (3)
IR 133	Diplomacy of Russia to 1945 (3) **or**
IR 134	Diplomacy of Russia Since 1945 (3)

II. Elective courses (3 credit hours); one course from the following:
any other Russian-language course (3)
any other Russian literature course (3)

Govt 318	Communist Political Systems (3)
Eco 309	Comparative Economic Systems (3)
Hist 361 or 362	(whichever is not taken under Section I) (3)
IR 133 or 134	(whichever is not taken under Section I) (3)

Special Topics courses in other areas such as psychology or social relations with permission (3)
Field Study in the Soviet Union for academic credit under Special Topics (3)

Science, Technology and Society Program

The Science, Technology and Society (STS) Program is a broad-based effort on the part of faculty members from all three colleges to foster undergraduate courses concerned with the interrelationships between scientific and technological advancement and the quality of human life.

The STS program offers a minor in Technology and Human Values, consisting of eighteen credit hours drawn from a variety of departments. For a full description of the courses offered, see page 218.

Urban Studies

The minor program in Urban Studies is a means of gaining broad insight into the nature and potentialities of the social sciences, besides being an appropriate vocational choice for students in fields such as civil engineering, management, architecture, and social work.

Urban Studies is designed to promote basic understanding of social processes, so that students will learn to perceive in their ever-changing communities opportunities for productive enterprises of their own. For some this will mean careers in public service, but others may contribute much to the betterment of society by successful work in the private sector. The minor in Urban Studies should be of particular interest to students in the College of Engineering and Physical Sciences as well as the College of Business and Economics who wish to maximize the educational value of their elective courses.

The minor consists of eighteen credit hours of course work selected in consultation with the program director, based on the needs and interests of the student with due concern for the over-all intellectual coherence of the program.

Certain other courses in relevant disciplines may be included by permission of the director of urban studies, David Curtis Amidon, Jr., minor adviser, 232 Chandler-Ullmann.

I. Required course (3 credit hours)
Urban Studies 61 The Study of Urbanization (3)

II. Elective courses (15 credit hours); from the following:

Arch 251	History of Urban Design (3)
Arch 210	Twentieth-Century Architecture (3)
Govt 77	Urban Politics (3)
Govt 328	Politics of Urban Educational Policy (3)
Govt 331	Internship Seminar (3)
Govt 360	Public Administration (3)
Hist 333	American Urban History to 1880 (3)
Hist 334	American Urban History, 1880 to the Present (3)
US 62	Contemporary Urban Issues (3)
US 125	American Ethnic Groups (3)
US 363	Philadelphia (3)
US 365	Lehigh Valley (3)
Eco 312	Urban Economics (3)
Eco 337	Transportation and Spatial Economics (3)
Eco 354	Public Finance: State and Local (3)
Clss 204	The Ancient City (3)
Anth 151	Utopias and Alternative Communities (3)
SR 368	The Urban Community (3)

Women's Studies

The interdisciplinary Women's Studies Program, located primarily within the College of Arts and Science, seeks to broaden knowledge about issues related to sex roles and society. The program offers a minor, consisting of eighteen credit hours, that represents the major research fields of Women's Studies. This minor program is open to anyone in the three undergraduate colleges.

In every society the distinction between the sexes is a significant factor in an individual's life. Socialization according to sex affects a person's expectations about appropriate work, social relations, and political position. By focusing attention on those spheres of life in which men have played dominant roles, traditional disciplines have tended to neglect the contribution of women to society and to underestimate the impact of gender differences upon social structure and human lives.

The women's studies minor is a supplement to any undergraduate major. It provides an integrated approach to the role of women in society from the viewpoints of a variety of academic disciplines. The program has three major goals: to promote an understanding of the traditional status and changing roles of women; to stimulate a critical examination of existing sexual roles and stereotypes and the evaluation of alternative arrangements; and to connect issues addressed in the classroom with those raised in the contexts of individual lives and society.

The minor consists of the basic course, Arts and Science 11, Sex Roles and Society, and a choice of five additional courses among those listed below. With the consent of a participating instructor, a student may substitute one Special Topics course. Students arrange their program in consultation with the director of the program, Elizabeth Fifer, department of English, Maginnes Hall.

I. Required course (3 credit hours)
Arts and Science 11 Sex Roles and Society (3)
(team-taught by the faculty of the Women's Studies Program)

II. Elective courses (15 credit hours)

Clss 250	Women in Antiquity (3)
Engl 77	Poetry of Women (3)
Engl 311	Literature of Women (3)
French 333	The Great Women Writers of France (in French only) (3)
Govt 179	Politics of Women (3)
Hist 124	Women in American History (3)
Mgt 472	Men and Women at Work (3)
Phil 126	Philosophical Issues in Feminism (3)
Phil 221	Sex Discrimination and the Law (3)
Psych 131	Psychology of Women (3)
RS 58	Women and Religion (3)
Soc 341	Women and Health (3)
Span 162	Women Writers of Latin America (in Spanish) (3)

Pre-Law Programs

The university has a strong pre-law tradition. In keeping with the policy of the Association of American Law Schools, the university does not have a prescribed prelaw program.

Lehigh students have been successful in attaining entrance into law schools from diverse curricula within all three of the undergraduate colleges.

An active student-run Pre-Law Society brings members of the legal professional and law school personnel on campus for discussion meetings and continuously provides information about law school opportunities.

Law-related courses, some of which rely on the casebook method, are provided by both the College of Arts and Science and the College of Business and Economics. In the former, for example, there is a course in International Law. In the latter, courses in law are regularly offered by the department of accounting and law.

Counseling is available to prospective prelaw students on a continuous basis from freshman orientation through the law school application process in the senior year. Counselors are members of the prelaw advisory committee, composed of faculty members of both colleges. Students are urged to consult members of the committee as early as possible in their academic careers.

Details on the Law and Legal Institutions minor program are found on page 40.

College Scholar Program

The College Scholar Program offers the qualified student a unique opportunity for maximum enhancement of critical faculties, abilities, and intellectual interests. This end is achieved through a structured program conforming to exceptional standards of breadth and rigor.

Undergraduates in the College of Arts and Science may apply for acceptance into the program at any time during the college career. An application is made to an honors committee, and acceptance is governed by the performance of the student to date and the committee's estimate of the likelihood that he or she will be able to fulfill the requirements of the program.

In order to be graduated with the designation "College Scholar," a student fulfills the requirements and achieves a cumulative average of 3.5.

Each student is required to have an individually structured program that must be approved by the director of the College Scholar Program. No course taken pass/fail may be used to satisfy the requirements. The requirements:

Area of Concentration

The major. "College Scholar" candidates can have departmental or interdepartmental majors. The academic level expected of candidates in the area of concentration can be attained by satisfactory completion of courses such as those at the 400 level, independent study, etc.

Thesis. The student takes a certain number of hours in independent study or thesis courses, culminating in a thesis or research report. This is read and rated by an ad hoc committee of three faculty members, one of whom must be from outside the department or departments in which the student is doing major work.

Comprehensive. A comprehensive examination in the area of concentration is required; it may be written, oral, or both. A committee in charge of the examination includes at least one person from a department other than that (or those) in which the student is doing major work.

Distribution requirements

English. Engl 1 and either 2, or 10, 14, 16.

Language. Proficiency in a classical or modern foreign language is needed, sufficient to complete the work of the fifth semester in any 3-3-3-3-3 sequence of credit hours; in a 4-4-3-3 sequence, completion of a fourth semester is required. There is no restriction on the language acceptable.

Mathematics. One course from among: Math 21, 31, or 41.

Natural Science. Four courses are chosen from two of the following areas: astronomy, biology, chemistry, geology, physics, and psychology. At least one of these courses shall be in chemistry or physics, and at least one of the four courses shall include the accompanying laboratory course.

Social Science. Four courses are taken from the areas of archaeology, economics, government, history, international relations, psychology, social relations, and urban studies. At least one must be in economics and one in history.

Humanities. Four courses are chosen from the areas of speech and theater, literature (English and advanced courses in classical and modern foreign languages), music, philosophy, and religion studies. At least one of these courses must be in philosophy or religion studies, one in literature, and one in the creative arts (theater, music, and art and architecture).

Note: Each of the last three requirements is stated in terms of *areas*, not *departments*, in recognition of the fact that not all humanities courses are offered in the departments whose names appear under "Humanities," not all historical courses are offered by the history department, not all philosophy courses by the philosophy department, etc.

The committee makes the decision, in consultation with the appropriate departments, under which rubric a specific course may be counted. It also is empowered to admit what substitutions it deems wise.

Health Professions Programs

Schools of medicine, dentistry, and veterinary medicine stress the importance of a broad general education as well as prescribed studies in the sciences. As long as candidates have the essential courses in biology, chemistry, physics, and mathematics, they may major in any of the three undergraduate colleges.

A health professions advisory committee, which includes faculty members from biology, chemistry, engineering, and physics, provides information during freshman orientation to interested students and actively works with health-professions candidates from the sophomore year forward to assist them in planning for entrance into professional schools in conjunction with their major advisers.

The university affords a special baccalaureate doctor of medicine degree program for students interested in becoming physicians, and a doctor of dental medicine program for students interested in becoming dentists. A bachelor of arts in premedical science program is associated with the Medical College of Pennsylvania. A bachelor of arts program in predental science is available in connection with the University of Pennsylvania School of Dental Medicine. Descriptions of these accelerated courses follow.

Students interested in optometry, pharmacy, podiatry, and other allied health fields may obtain information from the health professions advisory committee in planning their courses with their academic advisers.

Accelerated M.D. Program

In cooperation with the Medical College of Pennsylvania, the university offers an accelerated six-year program that enables selected students to earn both the bachelor of arts degree in premedical science and the M.D. degree after a minimum of six years of study at the two institutions. The program was initiated in 1974, and approximately fifteen students are admitted each year.

The program includes two academic years and two summers at Lehigh, during which time ninety-three credit hours are earned toward the 120 required for the baccalaureate degree. Students entering Lehigh with sufficient advanced placement credit may minimize or eliminate the second summer session. The next four years are spent in the regular program of medical education at the medical college. After the first two years at the medical college, students will have acquired the necessary additional credit hours for the baccalaureate degree.

During the first two years at Lehigh, students are expected to make satisfactory progress in the academic areas as well as in the more subtle task of personal growth in those attributes ultimately needed as a physician.

Seminars are conducted on campus by Medical College of Pennsylvania faculty members, and students are assigned to MCP faculty advisers. MCP receives student grades and monitors student progress through regular counseling sessions and feedback from Lehigh staff.

MCP has specifically avoided setting arbitrary standards for performance in order to encourage students to pursue the more difficult courses and to range into new academic and extracurricular areas appropriate to the student's academic and personal growth.

The medical college reserves the right to withdraw an offer of acceptance if academic or personal concerns cause the college to question a student's ability to function as a physician. The college also reserves the right to require that a student spend additional time at Lehigh if the medical college feels that this is necessary for the student's academic or personal maturation. Experience with the program to date indicates that such action is rarely necessary. In addition, the student may elect to take additional time at Lehigh prior to matriculation at the medical college if he or she feels that this would be beneficial. Should this occur, the student would be eligible to defer matriculation at medical school for a period of time agreed to by the student and the medical college.

Application for admission to the program is made through the Lehigh office of admission. Criteria for admission include SAT scores (minimum combined score ol approximately 1300), scholastic achievement, maturity, and motivation for medicine. Preference is given to residents of Pennsylvania.

Interviews are not required at Lehigh, but students are encouraged to make arrangements to come to campus to have an interview and to become better acquainted with Lehigh and the special features of the program.

Year 1: Lehigh (fall) (18 credit hours)
Chem 21, 22 (5)
Math 21 (4)
Engl 1 (3)
elective (preliminary) (3)*
elective (preliminary) (3)*

Year 1: Lehigh (spring) (17 credit hours)
Biol 21, 22 (4)
Math 22 (4)
Engl 2, 4, 6, 8, 10 (3)
elective (preliminary) (3)*
elective (preliminary) (3)*

Summer 1: Lehigh (12 credit hours)
Chem 51, 53 (4)
Chem 52, 54 (5)
elective (preliminary) (3)*

Year 2: Lehigh (fall) (18 credit hours)
Phys 11, 12 (5)
Math 23 (4)
biology elective (3)
elective (preliminary) (3)*
elective (upper) (3)**

Year 2: Lehigh (spring) (19 credit hours)
Phys 13, 14 (4)
Chem 31 or 194 (3)
Biol 28 (genetics) (3)
elective (upper)**
elective (upper)**
elective (upper)**

Summer 2: Lehigh (9 credit hours)
elective (upper)**
elective (upper)**
elective (upper)**

*Preliminary distribution: two three-hour courses minimum from Area I (Humanities), Area II (Social Sciences), and Area IV (Foreign Language or Culture).

**Upperclass distribution: twenty credit-hour minimum in Areas I and II, with a minimum of two three credit-hour courses in each of the two distribution areas.

Accelerated Program in Dentistry

The university, in cooperation with the School of Dental Medicine at the University of Pennsylvania, offers an accelerated seven-year program that enables selected students to earn a combined baccalaureate and doctor of dental medicine degree after a minimum of seven years of study at the two institutions.

The program includes three academic years during which time ninety-five credit hours are earned toward the baccalaureate degree. The next four years are spent in the regular program of dental education at the School of Dental Medicine in Philadelphia.

During the first three years at Lehigh, students are expected to make satisfactory progress in the academic areas as well as in the areas of personal growth, developing those attributes ultimately needed to become a dentist. Students must maintain a minimum 3.0 grade-point average throughout their three years at Lehigh.

The dental school reserves the right to withdraw an acceptance if academic or personal concerns cause the college to question a student's ability to function as a dentist. The dental school also reserves the right to require that students spend additional time at Lehigh if the school feels that this is necessary to insure the student's academic or personal maturation.

Application to the program occurs when a student applies to Lehigh University. The dental school takes action on the applicant and interviews candidates from mid-February to mid-March of an academic year. Final decisions are forwarded to Lehigh University about March 20. The applicant is notified of joint acceptance by Lehigh University. Admission is based on SAT scores (a minimum combined score of 1200), scholastic achievement, maturity, and motivation for dental school.

Year 1, fall: (14 credit hours)
Chem 21, 22 (5)
Math 41 (3)
Engl 1 (3)
elective* (3)

Year 1, spring: (16 credit hours)
Biol 21, 22 (4)
Math 44 (3)
Engl 2 (3)
elective* (3)
elective* (3)

Year 2, fall: (15 credit hours)
Chem 51 (3)
Biol 28 (3)
elective* (3)
elective* (3)
elective* (3)

Year 2, spring: (17 credit hours)
Chem 52, 55 (5)
Biol 135 (3)
Math 42 (3)
elective** (3)
elective** (3)

Year 3, fall: (17 credit hours)
Phys 11, 12 (5)
Biol*** (3)
elective** (3)
elective** (3)
elective** (3)

Year 3, spring: (16 credit hours)
Phys 13, 14 (4)
Biol*** (3)
chem 31 (3)
elective** (3)
elective** (3)

*Preliminary distribution: two three-hour courses minimum from Area I (Humanities), Area II (Social Sciences), and Area IV (Foreign Language or Culture).

**Upperclass distribution: twenty hours in Area I and Area

II with a minimum of two three credit-hour courses in each of the two areas.
***Approved program courses with consent of adviser.

College of Business And Economics

Richard W. Barsness, *dean*; Robert H. Mills, *associate dean*; Joseph P. Klein, *assistant dean*

The College of Business and Economics offers the bachelor of science degree in business and economics, which couples a liberal educational background with an understanding of the complexities and processes of management. It can serve as the basis for a career in business or for professional studies in fields such as law, business, or related fields. Qualified students can opt to continue their studies for an extended fifth year and acquire a master of business administration degree.

The College of Business and Economics is a member of the American Assembly of Collegiate Schools of Business. It offers a program of undergraduate study designed to provide an understanding of the complexities of the managerial process in society, both within and outside the business firm.

Five major programs are offered:

Accounting
Economics
Finance
Management
Marketing

Many of the most difficult societal problems today involve decision-making, conflict resolution, and the efficient and effective management of human and physical resources. Studies of business and economics provide fundamental bases for understanding and approaching solutions to aspects of these problems, particularly as they present themselves to business leaders and administrators in other fields.

Thus the college's undergraduate business program stresses analytical and communication skills for the development and articulation of problem-solving techniques. Educational breadth equivalent to many liberal arts programs is accompanied by depth of study of business processes such as accounting information systems, financial flows and markets, management processes, and the impact of economic variables and forces upon business and social issues.

Goals of the College

Objectives of the College of Business and Economics are to provide an understanding (at the undergraduate level) and managerial and/or research-teaching expertise (at graduate levels) of the nature of business enterprise decision-making and resource management in the economy. Undergraduate objectives may be summarized as follows:

1. To provide tools of analytical rigor and perspective for continuing learning abilities with respect to the nature of business and its role in the economy.

2. To increase communication skills.

3. To provide breadth of appreciation of the scientific, technological, social and human features of the world in which business is carried on.

4. Through a common body of knowledge, to stimulate interest in and acquaint a student with basic business and economic systems of pricing, resource allocation, financial and managerial accounting, financial management, information systems, distribution, and management processes.

5. Through a major, to provide each student with a learning exercise in depth in at least one area of business or the economy in which business operates, such as accounting systems, finance, economics, economic statistics, foreign careers, management, or marketing.

6. To work increasingly with mature students in intermediate and upperclass subject areas of business and economics, as an introduction to professional work or a sound basis for acquiring experience in the field or for graduate education.

Breadth of Study

In essence, the undergraduate education deemed most suitable for young men and women who will be the business leaders of tomorrow is formulated as analytically rigorous but with broad educational foundations combined with in-depth understanding of business processes in the economy in which we live.

This education in fundamentals, principles, and problem-solving mental agility provides graduates with various options. Some of the students choosing this curriculum have already settled upon business careers. Others will use it as a base for further professional studies in law, graduate business schools, or specialized graduate training in economics, operations research, or other related fields. Still others go into administrative careers in government or nonprofit institutions such as hospitals and universities. Others apply their talents to professional accounting, financial investment, or management consulting careers. Others teach economics or administrative science.

Undergraduate education must first provide the solid base of analytical skills and acquaintance with a sement of significant and relevant phenomena of our society. Equipped then with learning skills and intellectual facility in problem solvin, the student's ultimate career must be of his or her own making.

Business today can no longer be approached with narrow or superficial vocational training. Its problems are strongly conditioned by the state of the economy and even by social issues confronting modern business executives. Thus a strong basis in the social sciences is essential to understanding the nature of business organizations. The student must also be familiar with physical sciences and technology. Finally, mathematics and computer systems are essential elements of modern decisionmaking processes. An introduction to all of these is provided in the undergraduate program in business and economics.

There are three departments through which much of the student's work is carried out: accounting and law; economics; and management, finance and marketing.

Variety of Options

The student of today must be provided with options. Initiative and motivation would be stultified in a straightjacketed curriculum. To avoid such rigidity, the necessary exposures to science, language, and other arts are accomplished by optional requirements, within each of which the student has wide choice. Thus the basic curriculum rationale is similar to a distribution requirement in liberal arts to guarantee breadth of undergraduate educational experience. Additionally, however, approximately twenty credit hours required for graduation are completely open for selection on a free-elective basis.

The degree of bachelor of science in business and economics may also lead to achievement of the master of business administration degree in the college or at another institution for qualified students.

In addition to the master of business administration, the college also offers the following post-baccalaureate degrees: the doctor of philosophy, the master of arts, the master of science, and the master of science in management science. These are described in Section IV.

Bachelor of Science in Business

To obtain the bachelor of science degree in business and economics, 120 credit hours are required.

College Core Requirements (55 credits)

English and mathematics (12 credits)

Engl 1	Composition and Literature (3)
Engl 2, 4, 6, 8 or 10	Composition and Literature (3)
Math 41	BMSS Calculus I (3)
Math 44	BMSS Calculus (3)

Note: BMSS stands for biological, management and social science.

Business and economics core (43 credits)

Eco 1	Economics (4)
Eco 145	Statistical Methods (3)
Eco 229	Money and Banking (3)
Eco 105	Microeconomic Analysis (3)
Eco 119	Macroeconomic Analysis (3)
Acctg 51	Essentials of Accounting (3)
Acctg 52	Essentials of Accounting (3)
Acctg 111	Computers in Business (3)
Law 201	Business Law (3)
Mkt 211	Contemporary Marketing (3)
Fin 225	Business Finance (3)
Mgt 269	Management of Operations in Organizations (3)
Mgt 270	Conceptual Foundations of Organizational Theory and Behavior (3)
Mgt 301	Business Management Policies (3) **or**
Mgt 306	Entrepreneurship and Business Policy (3) **or**
Eco 333	Managerial Economics (3)

Major Program (15 credits)

Before the end of the first semester of the junior year, students select a major or field of concentration. A major program consists of sequential or related courses in accordance with one of the designated major programs, as detailed in Section V. Five majors are offered: accounting, economics, finance, management, and marketing.

Optional Courses (30 credits)

The student elects three credit hours of courses from each of the following four groups:

1. English, speech, journalism, theater, or modern foreign languages.

2. Offerings in the government, history, international relations, psychology, and social relations departments (including urban studies).

3. Offerings in the art and architecture, classics, mathematics, music, religion studies, and philosophy departments.

4. Biology, chemistry, geological sciences, and physics departments.

The remaining eighteen credit hours are taken in any one or more of the departments listed in the four groups above or any one or more departments in the College of Arts and Science, as follows: biology, classics, English, art and architecture, geological sciences, government, history, international relations, mathematics, modern foreign languages and literature, music, philosophy, psychology, religion studies, and social relations. One-hour courses are not accepted for the optional courses but may be counted toward electives.

Electives (20 credits)

Normally, any courses for credit in the university for which a student has the prerequisites may be used as electives.

Advanced military science and aerospace studies courses may be counted as electives up to six credits, but freshman- and sophomore-level courses in military science and aerospace studies do not carry credit against the 120 credit hours required for graduation.

Planning Courses of Study

In addition to freshman English and mathematics requirements, each freshman enrolled in the College of Business and Economics registers for Eco 1.

For the fourth and possibly fifth courses, the freshman student takes courses toward the optional requirement each semester of the freshman year. The normal program for freshmen is fifteen credit hours each semester.

Acctg 51 is taken in the first semester of the sophomore year. Other business and economics core requirements should be selected with some sampling of introductory courses that may help the student choose the major in the junior year.

The pass-fail option is available for students in the college for elective credits. Courses with passing letter grades must be submitted to meet the core, major program, and optional requirements. Courses taken on a pass-fail basis are classified as elective courses.

The senior-year work must be taken at Lehigh.

Course Sequence

Freshman Year

first semester			*second semester*	
Engl 1	3 credit hours		Engl 2, 4, 6, 8, 10	3 credit hours
Math 41	3		Math 44	3
Eco 1	4	or	Eco 1	4
electives	6		electives	9
	16 credit hours			15 or 16 credit hours

Sophomore Year

first semester		*second semester*	
Acct 51	3 credit hours	Acct 52	3 credit hours
Eco 145	3	Acct 111	3
Eco 105	3	Eco 119	3
electives	6	electives	6
	15 credit hours		15 credit hours

Note: Many sophomore courses can be taken in either semester.

College of Engineering And Physical Sciences

Donald M. Bolle, *dean*; Curtis W. Clump and William E. Ohnesorge, *associate deans*

The College of Engineering and Physical Sciences offers the bachelor of science degree in eleven programs, combining a strong background in sciences and mathematics with General Studies requirements in humanities and social sciences. Students in college programs learn principles they can apply in future professional work; those who plan on further academic training can design a curriculum centering on interests they will pursue in graduate school.

The College of Engineering and Physical Sciences includes eight departments and offers undergraduate and graduate degree programs at the bachelor, master, and doctor of philosophy levels.

The undergraduate degree programs or curricula leading to the bachelor of science degree are:

chemical engineering•
chemistry or biochemistry
civil engineering•
electrical• and computer engineering

fundamental sciences
industrial engineering*
mechanical engineering* and mechanics*
metallurgy and materials engineering*
physics

*Accredited by the Accreditation Board for Engineering and Technology. Programs in chemistry and physics have been approved by the program review committee in these disciplines.

Information about each of these programs may be found under alphabetical listings in Section V.

Each of the curricula includes course requirements in the physical sciences, mathematics, engineering sciences, and the advanced engineering or science course work essential for the particular degree. In addition, each curriculum has General Studies requirements in the humanities and social sciences.

In the past engineering education was identified in terms of the needs of industry. Present-day engineering programs continue to provide and emphasize such preparation. However, the flexibility inherent in the curricula enables students to design personalized programs leading directly into other professional colleges or professions such as medicine, law, government, management, or architecture.

The college encourages such mobility. Experience shows that the background provided through the college programs, including —"the engineering approach" to identification, articulation and resolution of problems, finds increasingly wider applicability in those areas of activity that call for a combination of practical and conceptual intelligence.

The college recognizes that the four-year programs are not intended to train specialists in a given area but rather to educate students in terms of principles they will apply to problems they encounter in their future professional work.

The physical sciences curricula of the college stress fundamentals while providing opportunities for electives in each of the substantive fields within the sciences. Senior-year programs in the sciences can be planned to facilitate transition to either graduate school or industrial laboratories.

Undergraduates with interests in such topical areas as environmental control, biotechnology, or aerospace can pursue their interests through electives provided in each of the curricula. Effective preparation for graduate study in such specialties consists of basic programs in engineering and science, along with electives especially chosen for the field of interest. Such electives are chosen from among all the offerings of the university and usually taken during the senior year.

Change of Curriculum

The early indication of curriculum choice by students in their application to the university is not a commitment on their part. In the second semester of the freshman year, just prior to preregistration for the sophomore year, students indicate their choice of curriculum.

However, since the sophomore-year programs for several curricula are very much alike, it is possible to transfer from one curriculum to another as late as the end of the sophomore year. This is done by means of a petition following consultation with curriculum advisers. There are instances where such a transfer may require one or two courses to be taken during a summer session at Lehigh or elsewhere.

Five-year programs combining the liberal arts and engineering or electrical engineering and physics are also available. In each of these combined curricula, one bachelor degree is awarded upon the successful completion of four years of study, and a second bachelor degree is awarded at the end of the fifth year.

The college curricula are designed to provide students with as much latitude as can be made available without compromising the balance and integrity expected of them by accrediting agencies. This is satisfied with the minimum program of each curriculum. On the other hand, the college expects each of its students to take full advantage of all opportunities open to them and to complete normal programs. In each of the college curricula, a few junior- or senior-year electives are indicated as follows: elective (0-3), or electives (3-6), (6-9), etc. Normal programs are those including the higher of the two credit hours shown for each such elective, and minimum programs are those including the lower of the two numbers.

Personal Electives

The college, through its advisers, is prepared to help students to use the six to twelve credit hours of "personal electives" that make the difference between the minimum and normal programs, along with other electives as available in the curricula to develop a program of personal interest. This may take the form of some concentration in an option or specialty within a student's own degree program, or alternately in a topical area outside a student's own department or outside the college.

Qualified juniors in the college planning to continue their formal education in graduate school are urged to take advantage of the flexibility in their programs and design their senior-year program in a manner that provides an effective foundation for a graduate program. Qualified students who plan their programs in this manner can, upon recommendation of the department and with the approval of the dean of the Graduate School, receive credit towards their degree for graduate-level courses completed above the minimum undergraduate requirements.

Recommended Freshman Year For Engineering Students

The following is the recommended outline of work for the freshman year, satisfying the requirements for all students in the college. For schedules of the work required in the following three years, please refer to Section V.

Freshman year, first semester (15-16 credits)

Engl 1	Composition and Literature (3)
Chem 21, 22	Introductory Chemistry Principles and Laboratory (5) **or**
Phys 11, 12	Introductory Physics I and Laboratory (5)
Math 21	Analytic Geometry and Calculus (4)
Engr 1	Introduction to Engineering Problems (3) **or**
General Studies, elective (3-4)	Humanities or Social Science (GS) elective (3-4)

Freshman year, second semester (15-16 credits)

Engl 2*	Composition and Literature (3)
Phys 11, 12	Introductory Physics I and Laboratory (5) **or**
Chem 21, 22	Introductory Chemistry Principles and Laboratory (5)
Math 22	Analytical Geometry and Calculus II (4)
Engr 1	Introduction to Engineering Problems (3) **or**
General Studies, elective (3 or 4)	Humanities, or Social Science (GS) elective (3-4)

*Engl 4, 6, 8, or 10 may replace Engl 2.

General Studies Program: Humanities for Engineers

The General Studies (GS) program involves a minimum of twenty-five credit hours normally spread over four years. It is designed to enable students to range widely or to delve

deeply into the humanities or the social sciences with the purpose of exploring the value systems, assumptions, and methodologies contained in these areas.

Since all students in the college are expected to complete specified sequences of courses in the physical sciences, and other electives are available for related courses in natural sciences, the General Studies program is restricted to the humanities and social sciences.

In addition, students pursuing a bachelor of science degree program in the college can, if they so choose, organize their General Studies program to achieve a minor in any one of the established areas in the humanities or social sciences. This requires:

1. Identifying the area of interest, i.e., sociology, philosophy, art and architecture, literature, etc., and obtaining the approval of the director of the General Studies program. A conference with the director is the first step toward this goal.
2. Formulating a course program in the area of concentration jointly with a member of the faculty representing the area of concentration. The names of faculty representatives are given to students by the director of General Studies.

In general, the minor is earned upon successful completion of a program of not less than fifteen credit hours in the area of concentration. In each and every case the faculty adviser in the area of concentration or the director of General Studies must recommend the student's work for such recognition. It is desirable that students planning to earn a minor in General Studies initiate action soon after their freshman year but not later than the beginning of the fifth semester.

The General Studies sequence of the college starts in the freshman year with six hours of English composition and literature, and a three-credit-hour social science or humanities elective. In the sophomore year, four credit hours of economics are required. By the end of the senior year, a minimum of twelve additional credit hours (four courses) is completed to satisfy the requirement of a total of twenty-five credit hours in General Studies. Several courses, such as Hist 1 and 2, Course of Civilizations, and Phil 100, Philosophy of Contemporary Civilizations, have been developed to meet General Studies objectives.

Courses qualifying for credit in General Studies are as follows:

Required Courses (10 credit hours)
Engl 1 or 11, and one course from among Engl 2, 4, 6, 8, 10 or 12; Eco 1

Electives in humanities and social science (15 credits)
Art and architecture, any except Arch 145

Classics, any course

Computing and Information Science

CIS 202	Computer and Society (3)
CIS 301	Descriptive Linguistics (3)
CIS 324	Development and Decline of Human Information Processing Abilities (3)

Economics

Eco 105	Microeconomic Analysis (3)
Eco 119	Macroeconomic Analysis (3)
Eco 229	Money and Banking (3)
Eco 303	Economic Development (3)
Eco 305	The Economic Development of Latin America (3)
Eco 309	Comparative Economic Systems (3)
Eco 310	Economic Evolution (3)
Eco 311	Economics of Resource Use (3)
Eco 312	Urban Economics (3)
Eco 313	History of Economic Thought (3)
Eco 314	Energy Economics (3)
Eco 317	Development of American Business (3)
Eco 335	Labor Economics (3)
Eco 336	Business and Government (3)
Eco 337	Transportation and Spatial Economics (3)
Eco 338	Labor Market Institutions (3)

English, any course

Foreign language, any advanced course. If elementary modern language study is elected, a minimum of one year must be in one language in order to receive General Studies credit.

A student may not elect an elementary course in any language studied in high school without approval of the department of modern foreign languages.

Freshman Seminar

Government and Urban Studies, any course

History, any course

International Relations, any course

Journalism

Journ 21	Creative Writing (3)
Journ 22	Creative Writing (3)
Journ 114	Reporting on Public Affairs (3)
Journ 118	History of American Journalism (3)
Journ 120	Journalism Proseminar (3)
Journ 121	Law of the Press (3)
Journ 122	Law of the Press II (3)
Journ 123	Basic Science Writing (3)
Journ 124	Politics of Science (3)
Journ 125	Environment, the Public and the Mass Media (3)
Journ 126	Writing About the Environment (3)
Journ 131	Science Writing Practicum (1-3)
Journ 211	Problems in Advanced Reportage (3)
Journ 311	Science Writing (3)
Journ 312	Advanced Science Writing (3)
Journ 313	Special Topics in Science Writing (3)
Journ 315	Interpretive Writing (3)

Law 11

Introduction to Law (3)

Music, any course other than Music 21 to 78

Philosophy, any course except Phil 14

Psychology

Psych 1	Introduction to Psychology (3)
Psych 75 (Phil 75)	Behavior Control and Human Values (3)
Psych 81	Insanity: Psychological and Legal Views (3)
Psych 107	Child Psychology (3)
Psych 108	Adolescent and Adult Psychology (3)
Psych 115	History of Modern Psychology (3)
Psych 131	Psychology of Women (3)
Psych 154	Clinical Approaches to Human Behavior (3)
Psych 305	Abnormal Psychology (3)
Psych 342	Systems and Theories of Contemporary Psychology (3)
Psych 351	Piaget (3)
Psych 353	Personality Theory (3)
Psych 354	Personality Assessment (3)

Science, Technology and Society, any course

Religion Studies, any course

Social Relations, any course except SR 111, SR 112, Anth 232, Anth 337, Soc Psych 392, Soc Psych 391

Speech and Theater

Theater 1	Introduction to Theater (3)
Theater 15	Introduction to Technical Theater (3)
Theater 41	Acting (3)
Theater 71	Introduction to Theater History (3)
Theater 113	Stage Lighting (3)
Theater 115	Scene Design (3)
Theater 121	Acting II (3)
Theater 141	Acting III (3)
Theater 144	Basic Directing (3)
Theater 151	Costume Design (3)
Theater 245	Directing (3)
Theater 271	Playwriting (3)

Technical Minors

In addition to the General Studies minor, other minors are offered in technical or scientific specialties that are not normally included within the normal curricula. Each program contains at least fifteen credit hours of technical and or scientific courses. Often some of these courses can be chosen as approved electives in the student's major curriculum; others are chosen as free electives.

Technical and scientific minors are available in chemical processing (not open to chemical engineers), molecular biophysics (not open to engineering physicists or fundamental sciences majors concentrating in this area), production management (not open to industrial engineers), fluid mechanics, and solid mechanics.

In some special cases a student in the college, able to incorporate electives within the curriculum that happen to satisfy the requirements of a minor offered in the College of Arts and Science, can, with the permission of the adviser in that college, earn the minor.

The General College Division

The General College Division supplements the work of the established undergraduate curricula by meeting the educational needs of certain special groups of students.

The division aims to provide an opportunity for individuals who are not planning a four-year program to pursue general or specialized work. It can provide a trial period for those who wish to become candidates for baccalaureate degrees but whose preparatory training does not fully satisfy the entrance requirements for the curricula of their choice. Adults can continue their education in the General College Division without being committed to a restricted or specialized program.

Although all work available through the General College Division will be found at present among the regular offerings of the several departments, the work taken by students in this division is not regarded as primarily preparation for admission to the upper classes of the university; rather, the courses are looked upon as complete in themselves.

Each student in the General College Division has an individual program, one not subject to distribution or curriculum requirements, yet one limited by the student's ability to meet the prerequisites of the course that he or she desires to take. With but few exceptions, the student enrolled in this division enjoys the same privileges as all other undergraduates in the university, including eligibility for unrestricted prizes, access to student aid, and the right of petition; and is also subject to the same general regulations, those pertaining to scholastic probation not excepted.

The General College Division student will not, however, be a candidate for a degree, except in those instances where transfer to one of the undergraduate programs of study leading to degrees is approved by the committee on standing of students.

Continuing Education

Lehigh University offers a varied selection of continuing education programs for adult learners. Reflecting Lehigh's educational strengths, these activities are largely in the areas of career development, sophisticated technical training, and university-level cultural and personal growth experiences.

Continuing education programs are self-contained educational packages, designed to meet the needs of specific adult groups. Their content, schedules, and timing are adapted to best serve the audiences for which they are developed. Instructors are generally drawn from Lehigh's permanent faculty, but, on many occasions, distinguished men and women from outside the university are added. These programs carry no regular academic credit, but participants can earn continuing education (CEU's) in appropriate offerings. In awarding CEU's, Lehigh follows the guidelines developed by the National Council on the Continuing Education Unit.

Individual departments and research centers have presented continuing education programs for decades, creating a reputation for excellence and utility. Now the university has established an office of continuing education to serve as a central contact and coordination point. If you wish to receive information on current Lehigh continuing education programs, contact Professor James A. Brown, director, Office of Continuing Education, Sayre Building 26, Lehigh University, Bethlehem, Pa. 18015.

North East Tier Ben Franklin Consortium and Technology Center

Lehigh University has been designated by the Commonwealth of Pennsylvania as home base of the North East Tier Ben Franklin Consortium and Technology Center. Announcement of the action was made on February 28, 1983, setting the stage for the university to play a significant role in an innovative state program designed to link industry, government, and the academic world in an effort to stimulate technological innovations that could benefit the state's economy through the development and attraction of high-technology industrial concerns.

The consortium headed by Lehigh received an initial grant of $250,000 from the state. Members of the North East Tier consortium were required to match this amount. The objective was easily exceeded, so that more than $1 million was realized for the initial seed period of the program. There are nearly one-hundred members of the NET consortium, including twenty colleges and universities and fifty-four corporations, all located in the northeast region of Pennsylvania that includes the Lehigh Valley, the Wilkes-Barre/Scranton area, and Reading.

Initial funding called for a total of $1 million to be divided among four consortiums across the state. The governor, Dick Thornburgh, has proposed funding of $10 million annually, which would have to be matched by the consortiums. Areas of advanced technology that will be the thrusts of the North East Tier consortium include computer-aided design, computer-aided manufacturing, microelectronics, polymers, and biotechnology.

Michael G. Bolton, former Lehigh director of development, was designated as executive director of the North East Tier Ben Franklin Consortium and Technology Center, with the additional title of assistant to the president of the university.

IV

Advanced Study and Research

Since the university began to encourage the growth of graduate study and research in 1961, resources and facilities devoted to advanced work have greatly increased. Opportunities for graduate work are organized under the aegis of the Graduate School.

Lehigh University offers graduate degrees in the following subject areas: **applied mathematics**—M.S. Ph.D.; **biology**—M.S., Ph.D.; **business and economics**—M.B.A., M.A., M.S., Ph.D.; **chemical engineering**—M.S., M.Eng., Ph.D.; **chemistry**—M.S., Ph.D., D.A.; **civil engineering**—M.S., M.Eng., Ph.D.; **computer engineering**—M.S., M.Eng., Ph.D.; **computing and information science**—M.S.; **education**—M.A., M.Ed., M.S., Ed.D.; **educational technology**—M.S.; **electrical engineering**—M.S., M.Eng., Ph.D.; **English**—M.A., Ph.D; **geology**—M.S., Ph.D.; **government**—M.A., M.P.A., D.A.; **history**—M.A., Ph.D. (granted only to students already enrolled); **industrial engineering**—M.A., M.Eng., Ph.D.; **information science**—Ph.D.; **management science**—M.S.; **mathematics**—M.S., Ph.D.; **mechanical engineering**—M.S., M.Eng., Ph.D.; **metallurgy and materials engineering**—M.S., M.Eng., Ph.D.; **molecular biology**—M.S., Ph.D.; **municipal administration**—M.P.A.; **physics**—M.S., Ph.D.; **physiological chemistry**—M.S., Ph.D.; **polymer science and engineering**—M.S., Ph.D.; **psychology**—M.S., D.A., Ph.D.; **social relations**—M.A.; **solid-state research**—M.S., Ph.D.

Specific information about particular programs can be obtained by contacting individual departments.

Advanced study. Programs for advanced degrees normally include formal course instruction and independent research. Both are important. Research provides a principal method of training and education at an advanced level by allowing students to concentrate on a specific problem under the close direction of senior faculty members.

Research in the humanities or social sciences is facilitated by the holdings of Linderman Library, as well as the contacts its staff maintains with libraries nationwide. The library also contains a very good rare book collection. In addition, Lehigh is close to several excellent research libraries, including those at Princeton University, the University of Pennsylvania, and Columbia University.

Advanced work in engineering and various scientific disciplines requires laboratory facilities and specialized equipment, and Lehigh has numerous special laboratories to facilitate such research. These laboratories are located in Fritz Engineering Laboratory, which houses the civil engineering department and the world's second-largest universal hydraulic testing machine; Whitaker Laboratory, completed in 1965 for the chemical engineering and metallurgy and materials engineering departments and electron microscopy; Sinclair Laboratory, completed in 1970, for surface chemistry and coatings research; Packard Laboratory, for electrical and computer engineering, mechanical engineering, mechanics, and the Computing Center; Williams Hall, for biology and geological sciences; the Physics Building; the Seeley G. Mudd Building and Neville Hall, which houses the chemistry department and facilities; Coxe Laboratory, home of the Materials Research Center; Chandler-Ullmann Hall, for psychology; and the Sherman Fairchild Laboratory for Solid-State Studies.

Mart Science and Engineering Library serves the fields of engineering, mathematics, and the natural and physical sciences. Students in certain programs have access to facilities at industries in the Lehigh Valley.

Interdisciplinary research. Although most graduate students find their interests served by programs available within a single department, some may elect to work in interdisciplinary areas that reach into two or more departments. Generally, each graduate student's program can be designed to fulfill his or her interests subject to the requirement that the field thus defined has scope and depth appropriate for an advanced degree regardless of whether or not its boundaries fall into a single department. Faculty do not regard departmental organization as bounds to their scholarly interests.

In fact, one manifestation of the growth of graduate education at Lehigh has been the organization of interdisciplinary research centers and interdepartmental projects and cooperation. Recent success with mission-oriented re-

search using an interdisciplinary approach—that is, scientists and engineers working together on a basic problem—promises an interesting kind of graduate education.

Lehigh's interdisciplinary research centers offer an opportunity to implement this new approach by directing continuous attention to a given group of problems, stimulating interest in their solution, and, finally, mobilizing the talent across the campus that is required for meaningful research. Besides organizing research, the centers create new courses relative to their research.

The Graduate School

Jerry P. King, dean

Lehigh recently marked an important centenary—the hundredth anniversary of the granting of graduate degrees. Although the intention of granting advanced degrees was announced at the founding of the university in 1865, the first graduate degree, a master of arts, was awarded in 1882 to T.H. Hardcastle, Class of 1880, who wrote his thesis on Alexander Pope and delivered his master's oration, "The Rights of Man," at commencement in June, 1882.

The first Ph.D. was granted in 1893 to Joseph W. Richards, Class of 1886. Richards, who had a background in metallurgy and electrochemistry, taught at Lehigh until his death in 1921.

Women were admitted to the graduate program in 1918 when the faculty and the board of trustees agreed to grant the degrees of M.A. and M.S. to women, provided they attended classes in the late afternoon and on Saturdays "so that the general character of campus life shall not be affected." Three women received graduate degrees in 1921, the first women to complete graduate work at Lehigh. In 1929, the rule was changed and women were admitted on much the same basis as men.

In 1936, The Graduate School was established to administer all aspects of the graduate program. The Ph.D., which was temporarily discontinued in 1894, was reinstated in nine departments: chemistry, chemical engineering, geology, history, mathematics, mechanical engineering, metallurgical engineering, and physics. Tomlinson Fort, professor of mathematics, was selected in 1938 as the first dean of the Graduate School.

Despite this demonstrated interest in graduate education, it was not until 1961 that the university officially resolved to strengthen and expand graduate programs university-wide. Since then, graduate work has assumed increased importance and prominence and facilities and funding have increased tremendously. The present dean of the Graduate School, Jerry P. King, was appointed in January, 1981, to succeed Robert D. Stout, who was dean from 1960 until his retirement in 1980.

The College of Business and Economics

Richard W. Barsness, dean

The Graduate School, in conjunction with Lehigh's College of Business and Economics, offers the master of arts and master of science degrees in business and economics and the master of business administration, as well as the doctor of philosophy degree in business and economics.

Graduate education in the College of Business and Economics distinguishes by emphasis between professional management training through the M.B.A., which generally, though not always, concludes at the master's level, and graduate pursuit of business and economics subjects in depth for research and or teaching expertise through the doctoral and related M.A. or M.S. programs.

There are three departments in the college: accounting and law; economics; and management, finance, and marketing. Course descriptions can be found listed under these departments in the course description section of the catalog; more information about the various degree programs appears below. The college publishes a brochure describing its programs, which may be obtained by writing the Graduate School.

The School of Education

Perry A. Zirkel, dean

The School of Education is an administratively separate unit of Lehigh University but operates in conjunction with the Graduate School in regard to admission, registration, tuition, fees, transcripts, and other related matters. Degree requirements are also consistent with those established by the Graduate School.

The School of Education offers the master of arts in education, the master of education, the master of science in education, the educational specialist, and the doctor of education. More information about these degrees appears below.

The school was established in 1966, elevating it from its former departmental status under the College of Arts and Science. The School of Education is engaged in the preparation of elementary and secondary teachers in both school and nonschool settings; school and community counselors; school psychologists; school and college administrators; reading specialists and supervisors; curriculum specialists and supervisors; specialists in the foundations of education; specialists and supervisors in the education of mentally and emotionally disturbed children; teachers of preschool children, especially those children with handicaps; teachers for the social restoration of potential delinquents; and specialists in educational technology. The concentration in developmental education is intended for individuals who are interested in working in or becoming knowledgeable about learning centers in higher education.

The School of Education is interested in potential and established leaders in all aspects of educational endeavor. More than 500 students were involved in advanced study at the master's and doctoral levels in 1982-1983.

Through its working relationship with other colleges and universities in eastern Pennsylvania, Lehigh has undertaken to complement existing undergraduate preparation programs by emphasizing study at the graduate level. Off-campus course work and in-service projects are an integral part of many programs.

An intern teaching program is specifically designed for qualified persons holding bachelor of arts degrees who desire to enter the field of teaching. Those admitted to this program have the opportunity to accomplish their professional training and serve as salaried interns in the public schools. After two semesters of directed full-time study, students may begin the teaching internship. Upon completion of the fifth-year program and the required semesters of intern teaching, such students would ordinarily have completed requirements for the M.A. (secondary teachers) or the M.Ed. (elementary teachers), as well as state certification.

Organization. There are three departments in the school. They are:

Department of Administration and Supervision. Charles W. Guditus, chairperson. Elementary school principal, secondary school principal, school business manager, curriculum administration, school superintendent, college administration.

Department of Human Development. Raymond Bell, chairman. Elementary school counselor, secondary school counselor, community counselor, supervisor of guidance services, social restoration specialist, reading specialist, reading supervisor, school psychologist, measurements and research specialist.

Department of Instruction and Curriculum. Robert L. Leight, chairperson. Elementary teachers, secondary teachers, preschool teachers, special education teachers, career education teachers, educational foundation.

Consult the listings for the School of Education in Section V for courses offered by these departments. Consult the same section for courses offered in the graduate-level educational technology program.

Centennial School. The School of Education also operates the Centennial School—a laboratory facility for exceptional children that has both an elementary and

secondary component. Centennial School provides research opportunities as well as practical experience for advanced students in counseling, school psychology, special education, and reading.

The laboratory facility is housed in a former elementary school in the Bethlehem community.

The staff of the school is listed in Section VIII.

Undergraduate Minor in Education. Upper-level undergraduates are given an opportunity to take a minor in education that combines practicum activities with theoretical work, designed to provide a foundation for further educational studies at the graduate level. A description of the program is found on page 122.

Educational Service Bureau. The Bureau of Educational Service was organized in 1953 to provide professional assistance to public and private schools and various other educational groups.

The bureau renders professional assistance to educational institutions by a cooperative study of their problems, fostering research in the field of educational practice, and helping make the resources of the university more available to communities and agencies in need. In doing so, the bureau obtains the services of specialists from all areas of the academic profession.

Detailed information concerning assistance with specific problems can be secured from Charles W. Guditus, School of Education, Lehigh University, 524 Brodhead Ave., Bethlehem, Pa. 18015.

Admission to Graduate Standing

A graduate of an accredited college, university, or technical institution is eligible for consideration of admission in The Graduate School. Actual admission is subject to enrollment limitations in each department; the decision to admit a student to the Graduate School ordinarily rests with the chairperson of the applicant's major department and with the dean of the Graduate School.

An application for admission may be secured by writing to the Graduate School, Whitaker Laboratory 5, Lehigh University, Bethlehem, Pa. 18015.

An applicant may obtain graduate standing as either a regular or an associate graduate student.

Regular Graduate Students. Only regular graduate students can be candidates for graduate degrees. Application for admission as a regular graduate student must be filed at least thirty days prior to the start of graduate registration. In order to be considered for admission as a regular graduate student, the applicant must satisfy at least one of the following conditions: have an undergraduate grade point average (G.P.A.) of at least 2.75 out of 4.00; have an average of at least 3.00 for the last two semesters of undergraduate study; have scores at or above the 75th percentile on the Graduate Record Exam (G.R.E.) or other recognized test (all foreign graduate students are required to take the test of English as a foreign language and achieve a minimum score of 500); have a graduate G.P.A. of at least 3.00 on a minimum of twelve hours of graduate work completed at other institutions; and have successfully satisfied the probationary conditions as an associate graduate student discussed below. Satisfying one of these five conditions is a necessary but not sufficient condition for admission as a regular graduate student.

Individual departments may evaluate their candidates for admission according to higher standards and additional criteria. Individual departments should be consulted about required examinations for admission. For example, candidates for the M.B.A. program are required to take the Graduate Management Admission Test (GMAT).

Associate Graduate Students. Applications for admission to associate graduate student standing will be reviewed while regular graduate student applications are being evaluated. Associate graduate status may be offered to applicants who apply but fail to qualify for regular graduate status. Only associate graduate student applications will be considered during the late admission period between the end of the regular admission period and the first day of classes. Associate graduate students who are admitted at this time and who clearly qualify for admission as regular graduate students may petition for regular status after classes begin if all credentials are in order. There is no late application fee.

Applicants for associate status complete a simplified application form, which requires an unofficial rather than official transcript; letters of recommendation are not required. The registrar will require an official final transcript, however, before grades are released.

Enrolled associate graduate students may apply for regular graduate student status when the following conditions are met: completion of nine credit hours of courses numbered 300 or higher with no more than one grade of C, C+, or B- and all other grades of B or higher; and satisfaction of more rigorous probationary standards that may be imposed by individual departments. When these obligations have been satisfied, the student must petition for regular graduate student status by submitting regular admission documents not already on file. Courses completed during a successful probationary period may count toward a graduate degree if they are part of the approved program.

Registration

In order to maintain full-time enrollment status, a graduate student normally must register for a minimum of nine credits each semester. No graduate student may register for more than fifteen credits per semester. The maximum registration in a summer session is six credits. An audit is worth 0 credits. Generally, teaching assistants, research assistants, and graduate assistants must also register for nine credits in order to be considered full-time. Since there are exceptions, students should check with their departments for an explanation of full-time status. Students on assistantships are limited to a maximum of ten credit hours per semester. Fellowship and scholarship holders may register for a maximum of fifteen credits per term, while full-time university employees are limited to six credits per semester.

All graduate students using university resources must be registered.

Graduate assistants and teaching assistants who will be continuing from spring to fall are entitled to register for three thesis or dissertation credits free of charge during the summer sessions. Academic year assistantships, however, generally do not cover tuition costs for additional coursework. Summer graduate assistantships or teaching assistantships may carry some summer tuition remission; students should check with the Graduate School for more detailed information.

Registration Procedure. Graduate registration is held during the week preceding the start of classes. Students should contact their departments for a schedule of days advisers will be available to register students. Students in the School of Education should check with their departments for registration and semester class schedules.

To register, graduate students should complete registration forms and personal data sheets available in their departments. A course adviser will discuss course selections with students and sign registration forms upon approval. When registration forms have been signed, teaching assistants, graduate assistants, and fellowship and scholarship holders go to the Graduate School office in Whitaker Laboratory for the dean's signed approval of their tuition awards. Students whose tuition is some form of employee benefit go to the personnel office. Research assistants whose tuition is paid by payroll deduction proceed directly to the bursar's office. All graduate students must pay their tuition bills either in person or by mail at the bursar's office. Receipts will be issued upon request.

Late Registration Penalties. Registration between the second and tenth day of class during the fall and spring semesters, and the second and fifth day of class during the summer sessions will require a late fee of $25. Students who have not completed the registration process will not be permitted to attend class beyond the ten-day grace period during the regular academic year or the eight-day grace period during the summer sessions.

Services Provided by the Registrar. In addition to maintaining student academic files, the office of the

registrar fills transcript orders. The registrar honors written and over-the-counter requests to have transcripts mailed to schools and prospective employers. The first copy is sent free of charge; subsequent copies are sent for $1.00 each.

The office also forwards final grades to students approximately two weeks after each final exam period, provided student credentials are in order.

Graduation

Candidates for degrees to be conferred at Commencement in May or June must file an application for degree with the registrar by March 1. Candidates for degrees to be conferred on Founder's Day in October must file this form by September 1. Candidates for degrees to be conferred in January must file by December 1. Late application for a degree will incur a penalty fee of $25. (Graduate students should also note that they must indicate their intention to graduate by checking the appropriate box on their course registration forms. This should be done at the beginning of the semester in which the degree is to be received.)

Clearance. Graduate students must receive clearance from the university prior to the conferment of the degree. The following obligations must be satisfied:

- Students must be certain that they have completed all coursework for incompletes they may have received.
- Theses and dissertations must be cleared by the Graduate School office.
- Financial obligations must be met. Tuition, fees, bookstore charges, library fines, and motor vehicle fines must be paid before graduation.
- All library books on loan must be returned.
- Students must turn in their student identification cards at Linderman Library.
- The interdepartmental clearance sheet must be completed. This form requires the signatures of the student's department chairperson, the bursar, and the buildings and grounds supervisor before it is submitted to the registrar at least three days prior to graduation.

Tuition

Tuition for the 1983-84 academic year is $4,000 per semester for twelve or more credits. The cost per credit hour is $335. Tuition is expected to increase on a yearly basis. Graduate students may purchase various meal plans at the bursar's office. Information may be obtained by contacting the university's food services office.

Tuition Payment. Graduate students must register for courses and pay tuition bills at the bursar's office during the registration period held the week before classes begin. Students who mail their registration forms, personal data sheets, and tuition payments to the bursar's office must be certain that their forms are postmarked by the final day of the registration period.

Late Payment Penalty. Students registering late for classes during the first ten days of the semester will be charged a late registration fee of $25. Students may *not* register for courses after the tenth day of instruction, which is marked from the first day of classes rather than from the first day a specific course meets. Graduate students enrolled in the School of Education, whose classes generally begin approximately one to two weeks later, should check deadline dates with their departments.

Tuition Refunds. A student in good standing who formally withdraws from a course during the first eight weeks of the semester or reduces the course enrollment below twelve credit hours after the first two weeks is eligible for a tuition refund. The refund schedule for student withdrawals and course adjustments is as follows:

prior to the start of the semester	full, less $100 deposit
during first calendar week	80%
during second calendar week	70%
during third calendar week	60%
during fourth calendar week	50%
during fifth calendar week	40%
during sixth calendar week	30%
during seventh calendar week	20%
during eighth calendar week	10%

Students should note that the first calendar week is the week classes begin at the university.

Full tuition refunds will be granted for registration cancellations or reductions in rosters only when a written notice is presented to the registrar prior to the start of the semester. Cancellation and reduction notifications received after the start of the semester will be recognized based upon the calendar week in which they are received by the registrar. A student suspended or expelled from the university will not be granted a tuition refund.

Other Fees

Living Accommodations

The university maintains a graduate student housing complex in the Saucon Valley section of the campus that has 112 living units. This complex, identified as Saucon Married and Graduate Students apartments, provides units generally on a yearly lease basis. For the 1983-84 period beginning in September, the following monthly rents exclusive of utilities prevail:

efficiency unit	$195
one-bedroom unit	245
two-bedroom unit	275
three-bedroom unit	285

Other Fees (applies to prevailing circumstances)

per-credit charge (including audit)	$335
late registration	25
late application for degree	25
examination makeup (after first scheduled makeup)	5
transcript (first one free)	1
late payment (after announced date)	25
return check fine	10
food services card (replacement)	10
identification card (replacement)	5
application fee (for admission consideration)	20
language examination	15
thesis - master's dissertation	25
dissertation - microfilming	50
copyright fee	25
identification card (purchase)	10
placement fee, School of Education	15

supervision fee, School of Education (per three credits)

counselor intern	$100
counselor and school psychology clinic	100
social restoration intern	225
reading practicum	100
administration intern	225
elementary and secondary intern	225
special-education intern	225

maintenance of candidacy fee	200
education grant, per credit hour	160
research and graduate assistants tuition (per-semester charge based upon ten credits hours)	2,000

The university reserves the right at any time to amend or add charges and fees as appropriate to meet current requirements. Fees applicable to the 1984-85 academic year will be announced no later than January, 1984.
For the plan of payments, see page 15. For the schedule of refund of charges, please see column at left.

Financial Aid

Financial aid for graduate students can be either academic or non-academic. Teaching assistantships, research assistantships, some graduate assistantships, fellowships, and scholarships are academic awards made by individual academic departments or by the dean of the Graduate School. Several graduate assistantships unrelated to a particular area of study can be obtained by applying to administrative offices. Finally, loans and work-study employment are dist-

ributed by the office of financial aid.

Academic Awards. Applications for fellowships, scholarships, research assistantships, teaching assistantships, and graduate assistantships to begin in the fall term must be filed with academic departments no later than February 1 of that calendar year. After completing the standard application form, students should check their departments for a list of specific requirements governing the distribution of awards. Generally, a special committee formed by department faculty selects the recipients of these awards based upon merit; students are not required to submit a financial statement since the awards are not based upon need.

In addition to their stipends, graduate students holding half-time teaching or research appointments receive a tuition award. Fellowship holders receive a tuition award plus a stipend. Scholarship recipients are awarded tuition.

Teaching Assistants and Graduate Assistants. Teaching assistant (T.A.) and graduate assistant (G.A.) are technical terms used to describe specific types of Lehigh University student employees. The duties of T.A.s and G.A.s are generally set by the departments or offices that employ them, but certain conditions must be satisfied before a student can be classified as a teaching assistant or a graduate assistant.

These include:

- Each T.A./G.A. must be a full-time, resident Lehigh graduate student, which normally requires registration for at least nine credit hours per semester.
- A T.A./G.A. is a half-time position and each T.A./G.A. provides services to Lehigh University of up to twenty hours per week.
- Each T.A./G.A. must be paid a specific stipend, which is set for the academic year by the dean of the Graduate School after consultation with the director of the office of research and the director of budget.
- Each T.A./G.A. receives tuition remission for at most ten credit hours in a regular semester. No T.A./G.A. may register for more than ten credit hours.
- Each T.A./G.A. is appointed by a process which includes written notification to the director of budget and

There are a limited number of summer T.A./G.A. appointments. These T.A./G.A. employees must receive the same monthly stipend as academic year T.A./G.A. employees and must provide services of up to twenty hours per week to the university. Ordinarily, a summer T.A./G.A. registers for exactly three credit hours in each summer session of employment and receives tuition for academic year T.A.s/G.A.s.

A student who is a T.A./G.A. in the spring semester and who will be a T.A./G.A. in the subsequent fall semester, but not in the intervening summer, is entitled to at most three hours of thesis, research, or dissertation registration (not course credit) in the intervening summer without payment of tuition.

Quarter-time T.A./G.A. appointments are possible for full-time resident graduate students with stipends and tuition remission appropriately reduced.

Research assistantships. Assistantships for research (R.A.s) on various sponsored research projects are available through academic and research centers. Information is available from department chairpersons or from center directors.

Non-academic graduate assistantships. Graduate students may apply directly to administrative offices for graduate assistantships unrelated to their areas of study. The availability of these assistantships is based upon the needs of the individual departments. Graduate assistants are employed regularly by the Graduate School office, the office of the vice president and dean of student affairs, the dean of students office, the counseling service, and the office of career planning and placement services.

Loans and work-study awards. Students may apply for National Direct Student Loans (NDSL), Lehigh University loans, and work-study awards through the office of financial aid. Since these loans and work-study opportunities are offered on the basis of need, graduate students must file the Graduate and Professional School Financial Aid Service form (GAPSFAS) with the Educational Testing Service; and the Lehigh application for aid and their most recent tax return with the office of financial aid.

Guaranty Student Loans. Graduate students may also participate in the Guaranty Student Loan (G.S.L.) program. Applications for these loans may be obtained from a bank and will be processed by the office of financial aid. Graduate students are permitted to borrow up to $5000 per year as an entitlement if their incomes are under $30,000; guaranty student loans are available on the basis of need for students with higher incomes.

Proposed changes to the program may make graduate students ineligible for guaranty student loans; students may have to transfer a portion of their borrowing needs to the PLUS/ALAS program (Parent Loan for Undergraduate Students/Auxiliary Loans to Assist Students). A student is eligible to borrow a total of $8,000 under the combined Guaranty Student Loan and PLUS/ALAS programs.

Loan check refunds are issued by the bursar's office following the tenth day of instruction and after tuition fees have been covered.

Protection of Human Subjects in Research

The investigator holds the primary responsibility for the protection of the welfare and the right of privacy of individual human subjects. Responsibility is shared by the university and, when outside support is provided, by the sponsoring agency. Students, faculty, staff, patients, and members of the general public qualify as human subjects if they are used by the investigator as a source of data, which may be identifiable private information.

The Office of Research. Students conducting scientific research involving the use of human subjects must secure authorization through the Office of Research before beginning investigation. After reviewing student proposals, the director of the Office of Research sends copies of the proposals to the institutional review board for approval.

The Institutional Review Board. The institutional review board is comprised of five ex-officio members of the faculty, who act as the executive committee, and a number of associate members pooled from the faculty, staff, students, and general community. These members, selected on an as-needed basis, review projects that fall within their areas of expertise.

The executive committee determines whether or not human subjects may be "at risk." An individual is considered "at risk" if he or she is exposed to harm—physical, psychological, social, legal, or other—as a result of participation as a subject in an investigation. Upon determining that a subject may be at risk, the executive committee convenes an appropriate project review panel from the pool of associate members to make the decision. After the review panel decides that risk is involved, it determines whether: the potential benefits to the subject and the importance of the knowledge to be gained through research will outweigh the risks to the subject; the rights and welfare of human subjects will be protected; appropriate methods will be used to obtain legally effective informed consent in accordance with the provisions of the regulation of the Department of Health and Human Services; and the progress of the activity will be reviewed at timely intervals. The review panel may refer the proposal to the initiating investigator for clarification or alteration at any time during the review process. The investigator may then resubmit the proposal when the required changes have been made.

Approval of a proposed investigation is granted for one year commencing with the anticipated beginning date of the investigation. The investigator or supervising faculty member must initiate an annual review if the activity extends beyond the one-year time limitation. The study must be submitted at an earlier date if the design of the investigation is substantially modified. Any proposed changes to the approved project must be submitted to the director of the Office of Research for review.

Informed consent. Projects involving human subjects at

risk will not be approved unless evidence proves that legally informed consent to participate in the activity has been granted by the subject or by the subject's legally authorized representative. The subject or representative must exercise free choice without undue inducement or any element of force, fraud, deceit, or duress.

The subject must receive sufficient information in order to make this choice before the study begins. The institutional review board will determine whether informed consent has been granted on the basis of the following elements of information: a fair explanation of the procedure and purposes, with identification of experimental procedures; a description of discomforts and risks reasonably to be expected; a description of benefits expected; a disclosure of any appropriate alternative procedures; an offer to answer inquiries concerning procedures; notice that the subject is free to withdraw consent and discontinue participation at any time; and an explanation as to whether compensation and medical treatment is provided if physical injury occurs and, if so, what it consists of (applicable only when behavioral or biomedical research may result in physical injury).

Degree Information

The Master's Degree

Candidates for the master's degree have six years in which to complete their programs. Students should confer with their program advisers to be certain that their departments' specific course requirements are met. The following requirements must be satisfied by master's candidates in all departments.

Course requirements. A student's program must include: not less than thirty semester hours of graduate work; not less than eighteen hours of 400-level course work; and not less than eighteen hours of course work in the major of which fifteen hours must be at the 400 level. All course work for the master's degree must be taken under at least two instructors and must normally be done in attendance at Lehigh University.

Minimum academic standards. A student may receive no more than four grades below B- in courses numbered 200 or higher. Failure to do so disqualifies the student for further graduate study and for the master's degree.

Incompletes. A student must remove incomplete grades in courses within one year in order to receive credit.

Program for the master's degree. A student must complete a typed program of courses proposed to satisfy the degree requirements. This form should be submitted to the department chairperson and then to the graduate committee for approval as soon as possible after fifteen credit hours toward the degree have been completed. Approval of the program by the graduate committee signifies that the student has formally been admitted to candidacy for the master's degree.

Thesis and comprehensive exam. Candidates are required to submit a thesis or a report based on a research course of at least three credit hours, or to pass a comprehensive examination given by the major department. The department will specify which of these requirements applies and may require both. If required, the thesis or report shall not count for more than six credit hours. University procedures must be followed if the thesis or research project involves human subjects. (See section on the protection of human subjects in research, above.) One unbound original typescript of the thesis, approved by the thesis adviser, and two additional copies of the abstract bearing the title and author's name must be delivered to the dean of the Graduate School at least three weeks before the conferment of the degree. A binding and microfilming fee must be paid to the bursar. The student must present the bursar's receipt for payment with the completed thesis to the dean. A list of requirements governing the form of the thesis is available in the Graduate School office.

After the student has completed all courses required for the master's degree, one term of grace is allowed for the completion of the thesis or removal of incompletes without further registration. Thereafter, the student must register and pay tuition ($150) in the semester in which the degree will be conferred.

The Doctor of Philosophy

A candidate for the doctor of philosophy degree is expected to devote at least three academic years to graduate work. All post-baccalaureate work toward the doctorate must be completed within ten years. A student beginning Ph.D. course work after an elapsed period of at least one semester after the master's degree has been conferred is granted seven years in which to complete the doctoral program.

Doctoral students must pay tuition equivalent to three full years (ninety credit hours) beyond the bachelor's degree or two full years (sixty credit hours) beyond the master's degree. Until these fees are met, resident doctoral candidates must pay a minimum registration fee for nine credit hours each semester and one summer session. Part-time doctoral candidates must be registered for three credit hours each semester and one summer session. Thereafter, doctoral candidacy must be maintained by a maintenance of candidacy registration fee of $200 each regular semester and one summer session including the semester in which the degree is granted. However, resident students who during their entire doctoral program, including the semester of graduation, have paid continuously full tuition (or ten hours per semester in the case of T.A.s and R.A.s) will have satisfied the tuition requirement for the doctoral degree upon completion of all other degree requirements.

Residence. Each Ph.D. candidate must satisfy Lehigh's residence requirement. The residence requirement is intended to insure that doctoral students spend a period of concentrated study and intellectual association with other scholars. Either two semesters of full-time graduate study or 24 credit hours of graduate study within a twelve-month period must be completed.

Individual departments may impose additional stipulations. Candidates should check with their advisers to be certain that they have satisfied their residence requirements.

Language requirements. Language requirements for the Ph.D. are the option of and in the jurisdiction of the candidate's department. Since proficiency in a language is not a university requirement, each department decides which languages, if any, constitute part of the doctoral program.

Qualifiers. Many departments require students who wish to enroll in doctoral programs to pass qualifying examinations. Since these examinations vary among departments, students should ask their advisers or department chairpersons for more detailed information. If a qualifying examination is not used, students should find out how and when eligibility to pursue doctoral studies is determined.

Admission to candidacy. With the help of an academic adviser, the student names the faculty members of the doctoral committee, a special committee formed to guide the student through the doctoral program. The committee is responsible for assisting the student in formulating a course of study, satisfying specific departmental requirements, preparing for final examinations, submitting a suitable dissertation proposal, overseeing progress in research, and evaluating the completed dissertation. At least four faculty are appointed to the committee; one must be a member of an outside department. Committee membership must be approved by the university's graduate committee.

A doctoral student should apply for candidacy no later than one year after completion of the master's degree or its equivalent and after passing qualifying examinations if they are required by the major department. The prospective Ph.D. candidate must submit to the doctoral committee a written program proposal that includes a discussion of proposed dissertation research. Upon receiving approval of the proposal, the candidate may then submit the proposal, via the dean of the Graduate School, to the university's graduate committee for formal acceptance to candidacy for the degree. The dean will

advise the student of the graduate committee's decision.

If the dissertation research involves human subjects, university procedures must be followed. (See section on the protection of human subjects in research.)

Maintenance of candidacy. When tuition fee obligations have been met, students must maintain their doctoral candidacy be registering for maintenance of candidacy ($200) each semester and one summer session each year until the degree is awarded.

General examinations. Examinations composed and administered by the members of the student's departmental doctoral committee are designed to test the candidate's proficiency in a particular field of study. These examinations, which may be both written and oral, should be passed at least seven months before the degree is to be conferred. If a student fails the general examination, a second examination will be scheduled not earlier than five months after the first. If the results of the second examination are unsatisfactory, no additional examination is scheduled.

Dissertation and defense. The Ph.D. candidate is required to write a dissertation prepared under the direction of a professor in the department. The paper must treat a topic related to the candidate's speciality in the major subject, show the results of original research, provide evidence of high scholarship, and make a significant contribution to knowledge in the field.

Upon approval of the advising professor and, if required by the department, secondary readers, the dissertation is submitted to the dean of the Graduate School for inspection at least six weeks before the degree is to be conferred. Upon its return, the student should distribute copies of the paper to the members of the departmental doctoral committee for review and for suggestions for revision. The candidate then schedules a dissertation defense before the doctoral committee, additional faculty members the department may add to the examining committee, and the general public. The date of the examination is sent to the dean of the Graduate School.

After the dissertation has been defended and revised accordingly, the student must submit the final draft of the paper to the dean of the Graduate School for review by the university's graduate committee no later than two weeks before the degree is to be conferred. Two unbound copies must be delivered to the Graduate School office. (One unbound copy must bear the original signatures of the special committee members.) Two extra copies of the abstract, each bearing the title and author's name, must accompany the dissertation. In addition, the candidate must pay a microfilming fee of $50 and present a bursar's receipt for the payment.

A list of guidelines stipulating the standard form of the dissertation is available in the Graduate School office.

The Doctor of Arts

The doctor of arts degree (D.A.) is offered to students preparing for careers in college teaching in the fields of chemistry, psychology, and government. The program requirements are similar to those for the Ph.D. with the following exceptions: a broader distribution of graduate courses in the field; a minor area of study for students interested in bidisciplinary preparation for two-year college teaching; course work and training in interpersonal awareness; a supervised internship in college teaching; a research project appropriate to college teaching in the student's field of specialization.

For requirements for the D.A. in chemistry see the course listings in this catalog. Information on the D.A. in psychology is included with the course listings for psychology and the D.A. in government is listed with the course descriptions for that department.

Postdoctoral Study

A selected number of students who have completed the doctorate may participate in postdoctoral individualized study under the guidance of selected members of the university faculty. Postdoctoral programs foster broad educational and research development at advanced levels and provide opportunities to prepare for specific positions.

Graduate Degrees in Business

A candidate for admission to graduate study in the College of Business and Economics offers either the Graduate Management Admission Test (GMAT) for business degrees or the Graduate Record Examination (GRE) Aptitude Tests and the advanced test in economics.

Master of Business Administration

The master of business administration degree is designed to give candidates conceptual, analytical, and operational knowledge of decision-making processes in the management of human and physical resources.

Both internal and external aspects of enterprise and organization in modern economic systems impinge upon managerial roles. Education in the business professions requires understanding business functions and integrating them into the management process. The program requires generalized managerial competence but permits, if the student desires, advanced concentration in such fields as finance, marketing, quantitative or behavioral management, professional accountancy or economics, international trade and finance, labor relations, and so forth.

All candidates for this program are required to take the Graduate Management Admission Test (GMAT). Information about this test may be obtained at many counseling centers or by writing to the Educational Testing Service, Box 966, Princeton, N.J. 08541.

Program Prerequisites. Students entering the M.B.A. program should have completed college-level courses in principles of economics, calculus, and computer programming. In situations where a student claims proficiency with a high-level programming language without formal course work, the student can petition to have the prerequisite deemed satisfied. Failure to have completed the prerequisites in these areas will not necessarily result in a student being denied admission into the M.B.A. program. However, the student will be expected to complete the three prerequisites at Lehigh or elsewhere by the end of the first semester following matriculation.

M.B.A. Curriculum. Requirements are indicated in the model program below. Foundation courses in the various functional fields are completed in the first year of the program. As indicated, up to six of these courses may be waived outright, with four being subject to limited waiver, and advanced courses substituted if certain conditions are met. This means the minimum curriculum for any student will consist normally of ten courses and the maximum curriculum will consist of twenty courses depending on prior course work and program prerequisites, described above, having been fulfilled.

Six elective courses may be selected from any functional area, subject to limited waiver requirements, of which at least four must be at the 400 level and none at the 200 level. A maximum of two of the six elective courses may be taken in other academic departments at Lehigh (e.g., industrial engineering, psychology, etc.) with prior permission from the M.B.A. adviser and the other departments.

Typical M.B.A. program. The following is a 60-hour program that would be typical for a student enrolled full-time in Lehigh's M.B.A. program.

First Year

Fall Semester
Acct 403 Financial Flows and Accounting Measurements*
Eco 401 Basic Statistics for Business and Economics*
Eco 405 Microeconomic Theory*
Eco 409 Money, Banking, and Macroeconomic Analysis*
Mgmt 413 Organizational Behavior**

Spring Semester
Acct 413 Managerial Accounting**
Fin 411 Financial Management**
Law 403 Commercial Transactions and Business Organization*
Mgmt 401 Quantitative Methods*
Mktg 413 Marketing Managements**

Second Year
Fall Semester
Acct 421 Information Systems for Managers
Eco 421 Managerial Economics
Mgmt 423 Operations Management
M.B.A. Elective
M.B.A. Elective

Spring Semester
Mgmt 429 Managerial Policy and Decision-Making
M.B.A. Elective
M.B.A. Elective
M.B.A. Elective
M.B.A. Elective

*Waiver policy: Each of these courses may be waived in the event that a comparable course, or courses, (see course descriptions) was taken and a grade of B- or better was earned in a program completed not more than eight years before matriculation in the program.
**Limited Waiver policy: Each of these courses in the program may be waived depending on prior course work and academic performance as determined on a case-by-case basis by the M.B.A. adviser in accordance with guidelines established by the faculty. If any of these courses is waived, an advanced graduate-level course normally will be required to be taken and included in the program as one of the six M.B.A. elective courses.

The Master of Arts and Master of Science Degrees in Business and Economics

The master of arts and master of science degrees are offered to students interested in pursuing graduate work in economics or in economics and business.

A minimum of thirty semester hours of course work is required. At least eighteen of these hours must be taken within the College of Business and Economics. In addition, the student will be expected to pass comprehensive examinations in general economic theory and one other field in the college.

To qualify for the master of science degree, the student must also take Eco. 352, Advanced Statistical Methods, and Management 401, Quantitative Methods, as part of his/her thirty semester hours of course work.

The Master of Science Degree in Management Science

The master of science in management science program is directed toward integrating the scientific method with the functional aspects of organizations. By investigating the application of quantitative methodology and systems analysis in the context of such areas as accounting, applied economics, finance, marketing, production and public service, the program helps to develop a meaningful analytical perspective of business problems.

This integration provides the student with a broader perspective toward managerial decision making in private enterprise and/or public administration. Students with prior exposure as undergraduates to engineering, business, economics, mathematics or the physical sciences who desire a quantitatively oriented business program are ideal candidates.

Management science graduates may pursue a career as staff specialists or as line managers who must deal with the increasingly complex problems of industrial, commercial, and public service organizations.

At the completion of the degree requirements, the student is expected to have acquired competence in the areas of accounting, marketing, corporate finance, production, data processing, microeconomics, organizational behavior, business law, linear algebra, calculus, and statistics. Included is a three-credit research project or practicum aimed at providing the student with professional exposure while still in a formal educational environment. Each student conducts an empirical investigation of an actual management problem and submits an individual written report.

The Doctor of Philosophy Degree

The Ph.D. in business and economics is designed to provide advanced knowledge and the capacity to carry on independent research in various areas of business and economics. Holders of the Ph.D. are normally employed in academic positions in departments of economics or schools of business administration or in policy analysis and research positions in banks, business, government, and research organizations. Employment opportunities are excellent for holders of this degree.

The Ph.D. program requires a minimum of 60 semester hours of study, including dissertation, beyond the master's degree or 90 hours of study beyond the bachelor's degree. Each student is expected to choose three major and two minor fields of specialized study. Economic theory must be included as one of the major fields. Each student must take a research core of twelve hours and prepare for written and oral comprehensive examinations in the major fields. The chairperson of the doctoral committee will help arrange a plan of study suitable for each student's program and to help prepare him/her to pass the examinations.

Major and minor fields of specialization that are normally available include economic theory, environmental/resource economics, international economics, labor economics, managerial economics, money and banking, private finance, public finance, and quantitative methods/econometrics. Minor fields include accounting, marketing, organizational theory, business law, and other related areas in the college or university.

Under the guidance of a dissertation chairperson and committee formed after passing of the examinations, the candidate undertakes research culminating in an acceptable dissertation. The Ph.D. is awarded upon the successful completion of the doctoral dissertation and its oral defense.

Graduate Degrees in Education

Students enrolled in the School of Education should check with their particular departments for a list of regulations and requirements governing their degree programs.

Registration and class schedules. Because many graduate students in education are full-time employees in public school systems, the school's fall classes generally begin one to two weeks after the start of the regular university semester. The School of Education begins instruction on the Thursday following Labor Day in order to conform to the schedules of most public and private school systems. The spring semester schedule, however, is the same as that followed by the rest of the university.

The School of Education does not require pre-registration. Graduate registration is held the week before classes begin; fall registration is held one to two weeks following the regular university registration period.

Tuition. Students registering for education courses are awarded an education grant that reduces the per-credit tuition cost.

Financial assistance. The School of Education, because it does not generally offer undergraduate courses, cannot provide teaching assistantships for graduate students. Graduate assistantships and, occasionally, research assistantships are available through the school's three departments and through various administrative offices on campus. In addition, graduate students may be recommended for a limited number of fellowships and scholarships, which are awarded by the dean of the Graduate School.

Lehigh's Centennial School, a laboratory school for severely emotionally disturbed children, provides employment for some Lehigh education students. For example, graduate students may apply for teaching internships, which pay tuition plus salaries.

Master's Degree and Certification Programs

Master of education (M.Ed.). In addition to the study of educational research, this degree, requiring thirty credits in

education courses, provides specialization in a professional field. The department of instruction and curriculum offers the M.Ed. in elementary education, secondary education, and special education. The M.Ed. in education administration is offered by the department of administration and supervision. The department of human development offers the master of education in community counseling, elementary school counseling, secondary school counseling, guidance supervising, reading, reading supervising, and social restoration.

Master of arts (M.A.). The master of arts degree offered in the field of secondary education provides a major in education with an academic specialty. The student must take eighteen credits of graduate work in education plus twelve credits of graduate work in an academic field. The academic fields that cooperate with the School of Education in offering this program include: classical languages, modern foreign languages, English, mathematics, economics, government, social relations, history, international relations, and physical and natural sciences.

Master of science (M.S.). The master of science degree is awarded in the interdepartmental program in educational technology.

Education Specialist (Ed.S.). Specialized post-master's terminal degree programs for practitioners are available in school psychology and in educational diagnosis.

Certification and concentration programs. In addition to offering master's degrees, the departments of instruction and curriculum, administration and supervision, and human development offer certifications in various major fields of study. The School of Education also offers special twelve to fifteen credit programs that provide concentrations in gifted education, developmental education, and education of the severely/multiply handicapped.

The Doctor of Education (Ed.D.)

The doctor of education degree program provides specialized study in elementary education, special education, educational administration, counseling, reading, foundations of education, and research. Successful professional experience is required for admission to candidacy for this degree.

The requirements for the Ed.D. degree parallel those already stated for the Ph.D. degree with the following exceptions: language examinations are not required; and a statistics competency examination is required. The residence requirement for the Ed.D. is the same as that for the Ph.D.

Graduate Study for Engineering Professionals

All departments within the College of Engineering and Physical Sciences offer a cooperative program that allows an engineer working in industry to further his or her education while retaining a professional position. Students enrolled in this program may pursue an M.S., M.Eng., Ph.D., or D.Eng. at Lehigh while employed full-time, completing the course requirements for the degree in a period of time that does not greatly exceed that spent by full-time graduate students in residence at Lehigh.

A professional interested in participating in this program applies to The Graduate School through a participating department (see course listing for each department for specific areas of research, courses available, and departmental requirements). When accepted, he or she chooses the track best suited to his or her individual needs. Each track allows a student to obtain a master's degree; then, a highly motivated professional may pursue a doctoral degree if he or she chooses.

In any case, however, the residency requirements for the master's degree are fulfilled by spending only two semesters at Lehigh as a resident graduate student. During the intervening semesters or summers, the student returns to the full-time, professional position. (It is best to spend a fall semester and spring semester on campus to allow maximum flexibility in course selection.)

The thesis or project required for the degree sought is decided upon through mutual consultation among the student, the adviser at Lehigh, and the supervisor in industry. The thesis or project work is begun during the student's first semester at Lehigh with the body of work performed when the student returns to his or her position in industry. Then, the thesis is completed when the student returns to Lehigh.

Each student chooses a faculty member at Lehigh who serves as academic adviser, helps the student select appropriate courses, and oversees the thesis or project work. The student also has a corporate adviser, preferably the person to whom the student reports, or a senior, experienced member of the corporate staff. It is hoped that in many cases the interactions among faculty member, corporate adviser, and student/employee will form the basis for a continuing relationship between the university and industry that will allow significant and ongoing research areas to be addressed by a sequence of students seeking advanced degrees.

Throughout the program, the student remains an employee of the company or corporation and receives his or her salary as usual. (Lehigh considers that salary as a matter to be arranged between the student and the employer.) Students are responsible for the full tuition due the university, and are reimbursed by their employers in accordance with company policy. Generally this means that they must make satisfactory progress towards the degree sought and achieve acceptable grades in course work.

Because the program requires additional work by faculty and staff, the company agrees to donate a sum equal to the university's tuition to the department in which its personnel are enrolled. In addition, companies agree to assist the department in meeting laboratory, computer, and other research costs that accrue during the student's research or project work.

The program is structured to be flexible enough to meet the needs of professional participants, and the choice of approach will depend on the circumstances that pertain to particular industries and to the needs and interests of individual students.

A brochure describing this program in detail is available from the College of Engineering and Physical Sciences, Packard Laboratory 19, Lehigh University, Bethlehem, Pa. 18015.

Graduate School Organizations

Several organizations within the Graduate School have been organized to deal with educational policies concerning graduate students and faculty and to help graduate students present their ideas, problems, and complaints to the appropriate persons.

The Graduate Committee

The graduate committee consists of the dean of the Graduate School and twelve members representing the faculties of Lehigh's colleges and School of Education: four from the College of Arts and Science; two from the College of Business and Economics; four from the College of Engineering and Physical Sciences; and two from the School of Education. In addition, four graduate students from these divisions attend committee meetings as non-voting members.

The committee is instrumental in formulating educational policies on issues such as graduate admission procedures, curriculum, and administrative regulations. These recommendations are passed on to the university's educational policy committee for review and to the faculty for approval. Faculty-supported policies are then delivered to the board of trustees; if they receive the board's approval, they become official university policy.

The graduate committee interprets graduate educational policies. The committee has independent executive power with regard to graduate petitions. In order to provide a forum for complaints regarding academic and non-academic matters, the graduate committee will schedule hearings for individual graduate students' grievances. Students may petition, via the dean of the Graduate

School, for extensions of time to complete degrees and for reinstatement to programs. Students denied admission to the Graduate School, even though they are not members of the university community, may also present petitions to the graduate committee.

The Graduate Student Council

The graduate student council, comprised of one graduate student from each academic department, was established originally to facilitate communication among graduate students and to sponsor social events. Recently, however, the council has expanded its services to provide a forum for students' problems and complaints. Although the council can neither vote on university policy nor make decisions regarding an individual student's degree program, it can support graduate student petitions by making recommendations to the graduate committee and other decision-making groups.

The graduate student council periodically publishes and distributes the *Graduate Student Newsletter*. This publication contains information on upcoming campus events as well as council-sponsored activities. Ethnic pot-luck dinners, talent shows, trips, athletic events, and parties are among the functions sponsored by the council.

Interdisciplinary Graduate Study and Research

In addition to offering graduate degrees within academic departments, Lehigh University offers interdisciplinary graduate degrees in the fields of applied mathematics, polymer science and engineering, molecular biology, physiological chemistry, educational technology, and management science.

The university also affords opportunities for interdisciplinary study in areas of research. Programs in solid-state studies and municipal administration are examples.

In addition, Lehigh's eleven interdisciplinary research centers, nine institutes and two academic centers address the broad-based research needs of government, industry, and the social community. Organized to recognize research efforts in interdisciplinary problem areas, they supplement the university's academic departments. Graduate students pursuing M.S. and Ph.D. degrees in academic departments as well as students enrolled in interdisciplinary degree programs may pursue research opportunities in the various centers.

A complete listing of research centers, institutes, and other research organizations appears following the section on interdisciplinary graduate programs.

Financial assistance. Teaching assistantships and fellowships are provided by individual academic departments, while research assistantships are available through both academic departments and research centers. Students interested in research are encouraged to seek appointments with members of the faculty working in their area of special interest, with department chairpersons, or with center or institute directors.

Interdisciplinary Graduate Programs

Applied Mathematics

The committee on applied mathematics administers programs leading to the M.S. and Ph.D. degrees. These programs are interdepartmental and stress the application of mathematics to the physical and social sciences. They provide a broad, rather than specialized, training in these fields.

The programs also are designed for candidates who have a basic training, either at the B.A. or M.S. level, in a field other than applied mathematics. The committee encourages such applicants. The degrees are in applied mathematics with a minor in some specified field of the physical and social sciences.

A candidate for these programs must have a knowledge of basic undergraduate mathematics, which includes linear algebra and differential equations (for example, Math 205). If not taken previously, courses in complex variable theory and partial differential equations, although not prerequisites for admission to these programs, must be added to the student's course requirements.

All students in the Ph.D. program are required to pass a qualifying examination before the end of their fifth semester (not including summer sessions). For the M.S., a thesis is required in addition to the course requirements. Master of science candidates can enter the Ph.D. program after completing all course requirements (exclusive of thesis). The date of the qualifying examination for a student entering the program with an M.S.—not necessarily in applied mathematics—will be determined on admission.

Several types of programs that are available are listed below. These programs are not the only ones possible. Others can be arranged with the consent of the committee.

Core courses

Math 320, 322, (Phys 428 and 429 may be substituted)
ChE 464

Options

1. Engineering Sciences—required: Mech 411, 450
electives: Math 405; Mech 409, 421, 424; ME 448, 458, 459; CE 459; ECE 350, 409; Phys 369, 442; Geol 301; Biol 402

2. Econometrics—required: Eco 320 or 436, 351, 432
electives: Math 309, 334; Eco 453, 455, 456
IE 416, 418, 445, 439, 311

3. Applied Analysis—required: Math 309, 350; Mech 450, 411
electives: to be chosen from lists under 1 and 2.

For further information, write to Professor Gerald F. Smith, Linderman Library 30, Lehigh University, Bethlehem, Pa. 18015.

Clinical Chemistry

The M.S. program in clinical chemistry is offered by the department of chemistry in cooperation with the Lehigh Valley Hospital Center. It is directed toward training clinical laboratory scientists to be active in hospital-based and industrial laboratories in both patient sample service and new product development. The program requires fulfillment of a clinical laboratory practicum as well as a research project at the M.S. level. The core requirements for the degree are:

Chem 371	Elements of Biochemistry (I)	3
Chem 372	Elements of Biochemistry (II)	3
Chem 332	Analytical Chemistry	3
Chem 336	Clinical Chemistry	3
Chem 358	Advanced Organic Chemistry	3
Chem 437	Pathophysiological Chemistry	3
Chem 439	Clinical Laboratory Practicum	(1 or 6)
Chem 421	Research	

Electives or courses that may be substituted, upon an approved petition, for core requirements in clinical chemistry can be drawn from those listed in the Ph.D. programs in molecular biology or physiological chemistry (see below).

Students may be admitted into this program from undergraduate majors in chemistry, biology, medical technology, or other areas of the biochemical life sciences. One semester of undergraduate physical chemistry is required for the M.S. in clinical chemistry although in some cases this course may be taken while enrolled as a graduate student but for no graduate credit. Graduates of the program are encouraged to continue their education toward the doctorate in any of the several biological chemistry programs offered at Lehigh.

Educational Technology

The program in educational technology is designed to meet the growing need for trained personnel to effectively utilize microcomputer technology in education and training.

The primary emphasis of the proposed program is to train educators to teach *with* computers. This is in contrast to teaching *about* computers, which implies a computer science and/or a data processing orientation.

The master of science program and post-master's-study instructional technology are designed to admit a limited number of persons interested in developing a strong competence in the utilization of the microcomputer in education and training.

The educational technology program is structured around five primary training goals: to provide a strong technical background in microcomputer software design; to establish a knowledge base of microcomputer hardware/software and allied hardware/software appropriate to instruction and training; to establish a knowledge base of significant research findings in the areas of learning, teaching, training and evaluation; to establish learning experiences appropriate for professional education and training specialists; and to provide opportunities for direct experiences in an education or training environment.

Program requirements. The program requirements for an M.S. consist of the following thirty credit hours of approved graduate study:

Area 1: Microcomputer Programming (9)
EdT 311/CIS 311 and EdT 415 **or**
EdT 313/CIS 11 and EdT 417/CIS 217 **and**
EdT 419/CIS 211

Area 2: Microcomputer Software/Hardware (3)
EdT 421 **or** EdT 425

Area 3: Educational Processes and Theory (6)
AdmS/HD/I&C 403 **and** EdT 335 **or** EdT 435

Area 4: Instructional Applications (3)
EdT 343/CIS 343

Area 5: Directed Field Experience (3)
EdT 493

Area 6: Electives (6)

Management Science

The industrial engineering department, in conjunction with the department of management, finance and marketing, offers an interdisciplinary degree in management science.

The management science program is directed toward integrating the scientific method with the functional aspects of organizations by investigating the application of quantitative methodology and systems analysis in the context of such functional areas as accounting, finance, marketing and production. This integration provides the student with a broader perspective toward managerial decision making in private enterprise and public administration.

Undergraduates with a background in engineering, business, economics, mathematics, or the physical sciences who want a professional career as a staff specialist in management science are appropriate candidates. In addition, those candidates who intend to seek line manager positions find the management science background advantageous in dealing with the complex problems of industrial, commercial, and public service organizations.

The candidate is assumed to have acquired basic competence in the areas of accounting, marketing, corporate finance, production, data processing, microeconomics, linear algebra, calculus, statistics, and introductory operations research.

Required Courses

IE 418	Simulation
Mgt 321, IE 334	Organizational Behavior
or Mgt 412	and Structure
Eco 431	Business Policy
IE (Mgt) 430	Management Science Project

nine hours of quantitative methods
six hours selected from a functional area

The minimum program consists of thirty hours of approved course work.

Sample program

IE 418	Simulation
Mgt 221	Organization Behavior
IE (Mgt) 430	Management Science Program
Eco 431	Managerial Economics
IE 311	Decision Processes
IE 417	Mathematical Programming
Eco 455	Econometric Models
IE 325	Production Control
Fin 421	Financial Management
Fin 431	Advanced Investment Analysis and Portfolio Management

Molecular Biology

The molecular biology program committee, consisting of faculty from the departments of biology, chemistry, and physics, administers an interdisciplinary program in molecular biology leading to the M.S. and Ph.D. degrees.

The core courses provide a basic background in cellular and molecular biology, biochemistry and biophysics. Present active research areas include studies of molecular analysis of microbial behavior, biomolecular radiation damage, mitochondrial nucleic acids, viral diseases of fish, proteolytic enzymes of marine bacteria, assembly of viruses, cardiac enzymology, mechanisms of phosphate ester hydrolysis, and membrane biophysics.

Students are admitted to the departments of physics, chemistry or biology who have appropriate undergraduate preparation in the respective subject, or have backgrounds in molecular biology, biochemistry, biophysics, or microbiology.

Master's degree requirements. The requirements for the M.S. degree include thirty credits of graduate course work, eighteen of which are at the 400 level, and successful completion of a research project under the supervision of a committee member. A written report of the research must be approved by the research adviser and will be kept on file by the program committee.

Required courses

Chem 371	Elements of Biochemistry I	(3)
Chem 372	Elements of Biochemistry II	(3)
Phys 367	Introduction to Molecular Biophysics	(3)
Phys 368	Molecular Biophysics	(3)
	approved 400-level biology elective	(3)
	approved 400-level electives	(6)
Chem 479	Biochemical Techniques	(3)
Phys 491, 492, or Biol 407, 408, or Chem 474, 475	Research	(6)

Electives

Students normally select the 400-level biology elective from among the following, although others may approved.

Biol 416	Immunology
Biol 420	Cellular Mechanisms
Biol 425	Biological Electron Microscopy
Biol 445	Nucleic Acids
Biol 447	Experimental Molecular Biology

Additional required 400-level electives and supplementary courses may be selected from the lists below and above.

Phys 451	Topics in Biophysics	(1-3)
Chem 423	Bio-organic Chemistry	(3)
Chem 445	Elements of Physical Chemistry	(4)
Chem 476	Microbial Biochemistry	(3)
Chem 477	Topics in Biochemistry	(3)
Chem 480	Advanced Biochemical Preparations	(1-3)

Biol 325	Advanced Genetics	
Biol 353	Virology	
Chem 358	Advanced Organic Chemistry	
Chem 395	Colloid and Surface Chemistry	

Doctoral degree requirements. Course requirements for the Ph.D. in molecular biology are determined on an individual basis by the student and the dissertation committee. This determination is subject to approval by the program committee.

Before completing the requirements for the M.S. degree, a student who desires to pursue a Ph.D. takes a qualifying examination, which may be both oral and written, and is administered by the program committee. Upon successful completion of this examination (it may be taken no more than twice), the student, in consultation with the research adviser, selects a dissertation committee that consists of the research adviser, at least three members of the molecular biology program committee, and at least one faculty member who is not a member of the committee. The dissertation committee must be approved by the program committee and by the graduate committee of the university.

Sometime prior to seven months before finishing the dissertation, the student must pass a general examination administered by the dissertation committee. The material covered in this examination is not limited to material covered in courses or obtained through laboratory experience. The student may be tested on all and any areas of molecular biology.

Upon completion of a draft of the dissertation, the student takes the final examination, which is essentially a defense of the thesis.

Physiological Chemistry

The graduate program in physiological chemistry leads to the M.S. and Ph.D. degrees. This curriculum prepares individuals who want to pursue careers in biomedical research, teaching, or administration, or in some aspect of public health.

Individuals may elect to specialize in one of the following areas: nuclear medicine, medicinal chemistry, chemical and experimental parasitology, invertebrate pathobiology, comparative immunology, and chemical physiology. The core course distribution and selection of electives may be altered to reflect the area of specialization.

Students are enrolled in the department of chemistry and are provided with research space in the laboratories of the university's Center for Health Sciences.

Core Courses

Students select at least six of the following core courses:

Chem 303	Nuclear and Radiochemistry	(3)
Chem 336	Clinical Chemistry	(3)
Chem 371	Elements of Biochemistry	(3)
Chem 423	Bioorganic Chemistry	(3)
Chem 424	Medicinal and Pharmaceutical Chemistry	(3)
Chem 479	Biochemical Techniques	(1-3)
Chem 435	Advanced Topics in Clinical Chemistry	(3)
Chem 437	Pathophysiological Chemistry	(3)
Chem 477	Topics in Biochemistry	(1-3)
Phys 367	Introduction to Molecular Biophysics	(3)
HD 408	or any course in statistics	

Students, with the consent of their graduate committee members, may petition to substitute equivalent courses for some of the required ones. The substitution must be approved for the student's area of research concentration. In addition, each student selects, with the guidance of the committee, sufficient courses from the following to satisfy the requirements of the Graduate School.

Chem 310	Instrumentation Principles I	(3)
Chem 311	Instrumentation Principles II	(3)
Chem 358	Advanced Organic Chemistry	(3)
Chem 372	Advanced Biochemistry	(3)
Chem 421	Chemistry Research	(1-4)
Chem 423	Bioorganic Chemistry	(3)
Chem 424	Medicinal and Pharmaceutical Chemistry	(3)
Chem 441	Chemical Kinetics	(3)
Chem 445	Elements of Physical Chemistry	(4)
Chem 458	Topics in Organic Chemistry	(3)
Chem 476	Microbial Biochemistry	(3)
Chem 480	Advanced Biochemical Preparations	(1-3)
Chem 481	Chemistry Seminar	(1-6)
Biol 303	Invertebrate Zoology	(3)
Biol 320	Cell Physiology	(3)
Biol 322	Animal Physiology	(3)
Biol 353	Virology	(3)
Biol 402	Comparative Animal Physiology	(3)
Biol 405	Special Topics in Biology (microbiology)	(3)
Biol 413	Cytochemistry	(3)
Biol 421	Morphogenesis of the Lower Invertebrates	
Biol 425	Biological Electron Microscopy	(3)
Hist 339	Human Ecology and Public Health in America	(3)
Hist 340	History of American Medicine	(3)
IR 472	Special Topics (international public health policies)	(3)

Students admitted into this program may have majored in biology, chemistry, animal science, entomology, veterinary science, pharmacy, or some other areas of the life sciences.

All students in the doctor of philosophy program are required to satisfy one foreign language requirement and pass a qualifying examination. The completion of a research project is required of M.S. students. A dissertation is required of Ph.D. candidates.

For further information, contact Professor Ned D. Heindel, Chandler-Ullmann 17, Lehigh University, Bethlehem, Pa. 18015.

Polymer Science and Engineering

Lehigh has a diverse group of faculty members with strong, primary interests in polymer science and engineering. In order to provide better opportunities for courses and research in this interdisciplinary field, activities are coordinated through a polymer program committee, with representatives from the departments of chemistry, chemical engineering, and metallurgy and materials engineering, as well as from the Center for Surface and Coatings Research and the Materials Research Center. The committee reports to the chairman of the department of chemical engineering.

Qualified students with degrees in the above or related fields may pursue graduate studies within an appropriate department. The student's adviser may be in that department, in another department, or in a research center. In this case, the student receives a normal departmental degree, but emphasizes polymer courses and research.

Students also may elect to pursue studies towards an interdepartmental degree in polymer science and engineering. The procedures for this case are summarized below.

M.S. in polymer science and engineering. For the M.S., the student is expected to: obtain a total of thirty credits of graduate course work, eighteen at the 400-level and eighteen core credits, and complete a research report to the satisfaction of the faculty adviser, and file it with the polymer program committee.

The usual core courses are:

Chem (ChE) 390	Synthesis and Characterization Lab	(3)
ChE (Chem) 393	Physical Polymer Science	(3)
Chem (ChE) 394	Organic Polymer Science	(3)
ChE (Chem)	400-level polymer course	(3)
	Research	(6)

Because polymer science and engineering embraces many variations on the common theme of macromolecules, considerable flexibility in course selection should be main-

tained. If deficiencies exist with respect to other undergraduate courses, additional courses may be required; however, some requirements may be waived for a student who already has a background in polymer science or engineering.

In addition to the required core courses, at least nine elective credits are required at the 400 level. Typical appropriate courses are:

ChE (Chem) 482	Engineering Behavior of Polymers	(3)
Chem (ChE) 483	Emulsion Polymers	(3)
ChE (Chem, Met) 484	Crystalline Polymers	(3)
ChE (Chem) 485	Polymer Blends and Composities	(3)
Chem (ChE) 492	Selected Topics in Polymer Science	(3)
Met 334	Electron Microscopy and Microprobe	(3)
ChE 400	Thermodynamics	(3)
ChE 413	Catalysis	(3)
ChE 428	Rheology	(3)
Chem 445	Elements of Physical Chemistry	(4)
Chem 497	Topics in Surface Chemistry	(3)

Other courses may include thermodynamics, mathematics, mechanics, statistics, kinetics, solid-state, organic chemistry or biochemistry, etc.

Ph.D. in polymer science and engineering. For the Ph.D., the student must satisfactorily complete a qualifying examination in a relevant scientific or engineering discipline administered by the appropriate department, or, in the case of a student with a background primarily in polymers, by the polymer program committee; satisfactorily complete graduate course work determined in consultation with the thesis committee and as approved by the polymer program committee; satisfactorily complete, prior to completion of the Ph.D. dissertation, a general examination (reflecting the polymer field at large) administered by the polymer program committee; and complete and defend to the satisfaction of the thesis committee a dissertation and also a general knowledge of the field.

The thesis committee consists of the research adviser, at least two members of the program committee, and at least one faculty member who is not a member of the committee; the committee's composition is subject to approval by the polymer program committee and the graduate committee.

For further information, write to Professor John A. Manson, Materials Research Center, Coxe Laboratory 32, Lehigh University, Bethlehem, Pennsylvania 18015.

Solid State / Sherman Fairchild Laboratory

Several solid-state research programs leading to the M.S. and the Ph.D. degrees are available. The departments of chemistry, electrical and computer engineering, metallurgy and materials engineering, physics, and two interdisciplinary centers, the Materials Research Center and the Center for Surface and Coatings Research, participate in solid-state activities.

While degrees are granted by academic departments, arrangements may be made for students to carry out their thesis research in either research centers or academic departments, including departments other than their own.

The Sherman Fairchild Foundation has awarded Lehigh a total of $6 million in grants. These have provided: the Sherman Fairchild Laboratory, completed in 1976, a 16,800-square-foot building that now serves as the focal point of solid-state research activities at Lehigh; three endowed professorships, one each in physics, electrical engineering, and chemistry-materials; eight graduate fellowships; ten undergraduate scholarships, and funds for scientific equipment. Major facilities in the Fairchild Laboratory are a 3 mev van de Graaff accelerator producing both electrons and positive ion beams, and an electrical device fabrication laboratory for producing planar silicon-integrated circuits.

The Urban Observatory

The Urban Observatory is a unique and innovative effort to assist city officials in resolving the problems facing them today. It functions as a city center for the administration of research and strives to achieve a program of urban research that balances public officials' need for specific policy alternatives and academicians' desire to focus on and explain the underlying causes of urban problems.

Accomplishing this goal involves promoting interaction and cooperation between city hall and the academic community. The building of the institutional bridges that results from this city-university interaction is the heart of the Urban Observatory concept.

The Allentown Urban Observatory, located in City Hall in Allentown, Pa., works through Lehigh University to conduct a wide range of research on urban problems. Each year the Urban Observatory establishes a research agenda, with its policy board making the final decision on which projects will be carried out. This board consists of university officials as well as elected and administrative city officials.

Projects conducted to date have spanned a wide range of academic fields and university departments. Faculty, graduate students, and in some cases, undergraduates, have been involved in social science projects such as an input-output model of Allentown's economy and a citizen participation study; industrial engineering projects such as productivity studies; civil engineering research such as storm water management modeling; business projects such as creating an accounting and reporting system for Allentown community development funds; and interdisciplinary, urban technology studies such as resource recovery and geocoding.

The Allentown Urban Observatory began as one of ten smaller-city observatories scattered around the country. They were established in 1975 through the efforts of the National League of Cities after their initial program of ten large-city urban observatories had proved a success. Allentown Urban Observatory research projects have been funded by various federal, state and local sources; the original grant from the U.S. Department of Housing and Urban Development was administered by the National League of Cities. Currently, the City of Allentown provides the support for the Urban Observatory.

The fact that the university's involvement with the Allentown Urban Observatory is composed of individual research projects means that this is not a degree program or a center for any one type or area of research. It also means that this program offers a unique opportunity to employ faculty and students in using the city as an interdisciplinary laboratory for testing technologies to solve urban problems.

For additional information, contact the vice president for research; Dr. Roy Herrenkohl, director, Center for Social Research; or Dr. Arthur E. King, director, Urban Technology Program, Center for Social Research.

Research Centers And Organizations

Eleven interdisciplinary research centers, nine institutes, and two academic centers at Lehigh complement the efforts of the academic departments in developing the full research and educational potential of the university in special areas.

The centers and institutes represent research efforts based on the capabilities and interests of the faculty. Frequently, they relate to the broad-based research needs of government, industry, and the social community.

The goal is to provide an effective interdisciplinary framework for programs involving faculty members and graduate students interested in combining traditional

course programs with an interdisciplinary research experience.

The research centers, the institutes and other research-related organizations are administratively responsible to the vice president for research.

Research Centers

Research centers include the following: Center for the Application of Mathematics, the Biotechnology Research Center, Center for Health Sciences, Center for Information and Computer Science, Center for Marine and Environmental Studies, Computing Center, Center for Surface and Coatings Research, Center for Social Research, Energy Research Center, Fritz Engineering Laboratory, and the Materials Research Center. Personnel associated with these centers are listed in Section VI.

Center for the Application of Mathematics

The Center for the Application of Mathematics was established in 1965 in order to foster interdisciplinary research related to the application of mathematics, to draw on other disciplines for pertinent mathematical problems, and to encourage the development of advanced courses in the application of mathematics.

The center surveys the need for courses in the application of mathematics and is concerned both with the design of new courses and the reorganization of existing courses so that these needs may be better served.

Research activities. Research programs are currently in the area of nonlinear continuum mechanics, the propagation of waves in nonlinear media, variational calculus, numerical analysis and biomechanics.

The program on nonlinear continuum mechanics includes fundamental studies in the formulation of continuum theories, the study of anomalous flow phenomena in viscoelastic fluids, the study of finite elastic deformations and stability, and the thermomechanics of materials in which irreversible processes take place and long-range forces may be present.

The program of nonlinear wave propagation includes fundamental mathematical studies of the propagation of both stress and electromagnetic waves in nonlinear media and the application of these studies in a number of areas of physics.

Both the work on variational calculus and that on numerical analysis are mainly directed to the solution of nonlinear elliptic differential equations. The work on biomechanics is concentrated on the study of transport phenomena in the microcirculation. This includes studies of capillary exchange, interstitial fluid movement and lymph flow, as well as the convection and diffusion of small ions and molecules within the interstitial space. Mathematical studies of the transport and convection of oxygen in the microcirculation also are being conducted.

Educational opportunities. Through the committee on applied mathematics, personnel of the center administer an interdisciplinary program leading to the degrees of master of science and doctor of philosophy. These interdepartmental programs stress the application of mathematics to the physical and social sciences.

For further information, write to the center's director, Professor Gerald F. Smith, Linderman Library 30, Bethlehem, Pa. 18015.

Biotechnology Research Center

The Biotechnology Research Center was established in 1980 by uniting faculty from the departments of chemical engineering, biology, chemistry, and civil engineering. Its mandates are to encourage basic and applied research directed toward understanding, characterizing, and harnessing microorganisms, viruses, plant and animal cells, and enzyme catalysts; to maintain well-equipped state-of-the-art laboratories; to promote intellectual camaraderie and cooperative research among center members.

The center is one of the best-equipped basic and applied biotechnology facilities in the country. In addition to the laboratories of individual members (mainly biochemical and microbiological), the center has a central facility in Whitaker Laboratory comprising five separate laboratories with a total area of approximately 4,000 square feet. The central laboratory has basic microbiological and analytical equipment and is well equipped with fermentors including batch and continuous bench-top fermentors ranging from 300 cc to 14 liters; small, pilot-plant fermentors with capacities from 28 liters to 100 liters; a highly instrumented, computer-coupled (to a DEC 11/34), 70-liter fermentor; and a 300-liter Vogelbusch Deep-Jet Aeration fermentor (recirculation-type). Several of the pilot-plant fermentors and the Vogelbusch can be coupled to the DEC 11/34 computer when necessary for data logging or for on-line control. The central laboratory also houses an immobilized enzyme pilot-scale reactor system.

The financial mainstay of the center is standard contract research for government funding agencies and private companies. In addition, the Biotechnology Liaison Program encourages private companies to maintain strong ties with the university by supporting, through a single program, proprietary research and nonproprietary fundamental research of general interest. Through the program, member companies gain access to university resources, stay in touch with the current basic research in academe and have the opportunity to influence the direction and emphasis of this work. Center faculty associates and their students benefit by keeping aware of the latest developments and needs of the private sector and by being provided with new research ideas and opportunities. The program also provides a particularly good mechanism for students to learn about industrial goals and practices.

Research Activities. In general, center research activities include: basic microbiology and virology including strain selection and development; basic fermentation studies dealing with kinetics, transport phenomena, modeling, automatic control, optimization, and fermentor design; scale up of fermentation process; preliminary plant design; solid substrate fermentation; enzyme engineering; on-line computer control of fermentations; biological treatment of municipal and industrial wastes; recovery and purification of fermentation products; economic studies.

Current research at the center includes a large program devoted to the conversion of biomass to fuels and chemicals. Among the projects in this program are: batch and continuous fermentation of enzyme-hydrolyzed corn; effects of yeast recycle on alcohol yield and productivity; simultaneous hydrolysis and fermentation of cornstarch; development of cellulolytic bacteria; mechanical and chemical pretreatment of cellulosic feed stocks; combined saccharification and fermentation of cellulosic raw materials; optimization of cellulase production in batch and continuous culture; alcohol production by *Zymomonas mobilis*; preliminary design of an electrical power/alcohol cogeneration plant.

Research projects in other areas are: enzyme immunoassay conjugate synthesis; isolation of A/O process microorganisms; effect of ~29 nonstructural proteins on ~29 deoxyribonucleic acid; cell fusion as a method of viral attenuation; important yeast enzymes in ethanol biosynthesis; production and recovery of microbial polysaccharides (e.g., xanthan gum); microbial desulfurization of coal; fermentation broth rheology; solid substrate fermentation in static and rotating drum fermentors; computer control of fermentations; use of recirculation fermentors (e.g., Vogelbusch) for viscous and non-Newtonian fermentation broths; maintenance energy of *zymomonas mobilis*; extractive fermentation; computer simulation of fermentation plants; growth characteristics of Mycorrhizae; power uptake, oxygen transfer rate, and mixing time characteristics of the Vogelbusch fermentor.

Educational Opportunities. The center welcomes graduate and undergraduate students from any academic department to do degree or nondegree-related research under the direction of faculty associated with the center. Center activities and facilities are diverse and flexible enough to meet the needs of any student interested in aspects of biotechnology ranging from basic microbiology and

biochemistry to engineering design. Also, regardless of a student's specific goals, he or she will be immersed in a rich and stimulating environment where there is a high level of intellectual camaraderie and cooperative activity through which each center participant can obtain a good appreciation of a rather large segment of the general area of biotechnology.

Graduate students doing dissertation research in the center receive degrees from existing academic departments. (The center may not grant degrees.) Generally, the student's adviser will be a center faculty associate, although he or she may not be from the student's own department. This affords the student great flexibility in choosing a research area. Also, the close associations in the center make it easy for the student to obtain guidance from several faculty experts and, when advantageous, to have more than one adviser.

Courses dealing with all areas of biotechnology are offered through the departments of chemical engineering, biology, chemistry, physics, and civil engineering. Most are taught by the center's faculty associates who work together to integrate existing courses and to formulate new ones as the need arises. Also, the broad range of expertise allows for team-teaching of appropriate courses. The center encourages this approach because it makes courses more vibrant, more informative, and more authoritative and helps to stimulate intellectual interaction among the faculty members and among students.

The center sponsors a very active seminar schedule that includes prominent speakers from around the world. It also emphasizes heavily presentations made by faculty and students associated with the center. Seminar topics range from basic microbiology to the design and economics of fermentation plants.

Continuing education is another important educational activity of the center. This component includes, but is not limited to, short courses of various degrees of specificity as well as practical training programs dealing with subjects ranging from basic laboratory skills to the operation of large, computer-coupled fermentors.

For more information about the center's activities and financial assistance for graduate students, write to Professor Marvin Charles, director, Biotechnology Research Center, Whitaker Laboratory 5, Lehigh University, Bethlehem, Pa. 18015.

Computing Center

With a long heritage of teaching and research in engineering and science, Lehigh has made extensive use of computers for almost two decades. In 1966, the need was recognized for an independent organization serving the diverse needs of the academic community, and the Computing Center was formed. Today, the center is charged with the responsibility of serving existing needs while anticipating and preparing for the future requirements of its user community.

The center's principal facilities are located in Packard Laboratory. The Computing Center serves as a laboratory for departmental courses and research in computer theory and applications, including developmental programs. It provides computer and computing services for all departments and centers of the university for solution of instructional, research, and administrative problems. The center also serves as a laboratory for departmental courses and research in computer theory and applications, including developmental programs.

The Center's Control Data Corporation 6400 computing system was replaced in 1981 with CDC's latest computer offering, a CDC CYBER 170 Model 720 and upgraded in late 1982 to a model 730 dual CPU. This system is equipped with 256 kilowords (60 bits per word) of central memory, ⅛ megawords of extended core storage, 1.8 gigabytes of on-line disk storage, a telecommunication subsystem based on a CDC 2550 Network Processing Unit, three nine-track magnetic tape drives, two 1200-line-per-minute printers, one 1200-card-per-minute card reader, one 250-card-per-minute card punch, and a four-color Calcomp plotter. Principal high-level programming languages available on the system are FORTRAN, COBOL and PASCAL. In addition, various simulation and special-purpose languages and batch-oriented applications packages are provided.

In the fall of 1977, two computers were purchased from Digital Equipment Corporation—a medium-sized DEC 20/40 and a small PDP 11/34. The DEC 20 was upgraded to a 20/60 in 1979. The primary function of these computers is to provide additional time-sharing service to the Lehigh community. This system is equipped with 512 kilowords (36 bits per word) of main memory, 600 megabytes of on-line disk storage, one nine-track tape drive, one 240-line-per-minute, upper/lower case printer, one plotter, and a built-in communications and peripheral equipment controller based on a PDP 11/40 computer. Principal high-level programming languages available include FORTRAN, COBOL, PASCAL, APL and BASIC. A data base management system (DBMS-20) and an inquiry language (IQL) are supported, as are utilities primarily oriented to interactive computing.

The DECSYSTEM 20 also supports several word processing packages, an application that is growing rapidly. The PDP 11/34 system consists of a PDP 11/34A mini-computer equipped with 112 kilowords (16 bits per word) of main memory, one 180-character-per-second printer, and 35 megabytes of on-line disk storage. The BASIC and APL programming languages are available on the system. In addition, many small, interactive programs are provided.

Finally, in 1981, the Center acquired an IBM 4331, primarily for administrative use. The IBM 4331 system, mod II, is a virtual storage-based machine of 16 megabytes of virtual memory executing in 2 megabytes of real memory. The system is equipped with two nine-track magnetic tape drives, 1.7 gigabytes of disk storage, one 1200-line-per-minute printer. COBOL and FORTRAN are the primary high-level programming languages available on the system.

These upgrades and additions to the Computing Center make four well-known computer systems from three of the top manufacturers available. In addition to the computers, the latest operating systems and computer programming languages are available to the campus.

In 1983, the Computing Center provided a large number of public access terminals. In addition to the 34 dial-up terminals that can access either the CYBER, the DEC, or the PDP systems, the CYBER has 48 terminals hardwired to it, the DEC has 33, and the PDP has 12. The IBM system supports 40 interactive administrative terminals, 7 remote printers, and one remote batch station.

Research activities. To preserve its role of impartial support for all users, the center does not engage in primary research. It has, from time to time, conducted research-related activities on its own or in cooperation with academic departments or research centers.

The center's primary role in research is to support the computing activities of the research community. Approximately one-quarter of the center's computer utilization is devoted to the activity.

In the past, research activity using the computer has been largely associated with the College of Engineering and Physical Sciences. This distribution is gradually expanding with the application of computers in other disciplines within the College of Business and Economics, the College of Arts and Science, and the School of Education. Research centers find the use of computers helpful in the collection of laboratory and survey data and analysis and modeling using these data. The use of dedicated computers for the collection and analysis of data has been taking place in the physics department, Sherman Fairchild Laboratory, and the departments of mechanical engineering and mechanics and industrial engineering, to name a few. With the advent of networking technology, the communications between the center and other areas of the campus will increase dramatically.

Educational opportunities. Seminars on varied topics in computing are held or sponsored by the center for faculty, staff, and students on varied subjects relating to data

processing.

The center works closely with the Computer Society to meet the more independent inquiry needs of undergraduates, and the society's adviser is a member of the center staff.

Students desiring a more intensive educational experience in an operating environment may apply for part-time jobs in programming, user services, and operations.

Along with research, the center's primary method of offering educational opportunities in the use of computers is by providing computing resources for use by the academic community. More than one-third of the center's activity is devoted to instructional computing. The majority of jobs processed by the center are submitted by students as part of their normal academic activities. The growth of interactive processing facilities benefits these users primarily.

For further information, write to the director, Dr. J. Gary Lutz, Computing Center headquarters, 616 Brodhead Avenue, Lehigh University, Bethlehem, Pennsylvania 18015.

Energy Research Center

Energy research at Lehigh is a multidisciplinary activity, involving faculty and students from engineering, the physical sciences, life sciences, business and economics, and the social sciences. The Energy Research Center provides a structure within which faculty and students from different backgrounds can explore their specific research interests.

The center coordinates the university's energy research, helping the faculty respond to research opportunities and developments in energy. It is also the major contact between the university and industry and government for matters dealing with energy research. Originally founded in 1972 as the Task Force for Energy Research, the center was organized into its present form in 1978.

The research within the center involves a wide range of topics related to the supply and use of energy. Work in progress—supported by contracts and grants from government, industry, and private foundations—deals with fuels and energy resources, energy conversion systems, energy conservation and the environment.

The Energy Research Center has particularly close ties with industry. A number of joint research projects involve Lehigh faculty and students and research staff from industry. The center also operates the Energy Liaison Program, through which participating companies and government facilities have access to faculty consultants, make use of laboratory facilities and library services, and receive assistance on research problems, feasibility studies and other projects related to energy. Through the center's Energy Intern Program, opportunities also exist for students to receive part of their training in industry. Through this program, a graduate student involved in energy can do a research internship in industry under the joint supervision of company research staff and the student's faculty adviser.

Experimental support for energy research is provided in a number of specialized laboratories maintained by the university. These laboratories, furnished with the latest instrumentation and equipment, include the following: boiling and two-phase flow, fluidized bed, fluid mechanics, surface chemistry, chemical kinetics, GC mass spectrometer, atomic absorption spectrometer, electron optical, mechanical testing, structural testing, welding, metal forming, fracture mechanics, ceramics, polymer, hydraulics and water resources, van de Graaff accelerator, biotechnology, aquatic biology, and microprocessor development.

All faculty members who participate in Energy Research Center activities belong to academic departments. In addition, a number of faculty and staff members affiliated with the center have close ties with other on-campus research centers and institutes, assuring broad interactions between center personnel and experts from many research specialties, including economics, social science, materials and metallurgy, marine biology, fracture and solid mechanics, metal forming, structural design, sanitary and water resources engineering, thermal science, fluid mechanics, surface chemistry, and biotechnology.

Energy research. Research within the center falls within five major categories. Projects of interest include:

Fossil fuels. Fluidized bed combustion of coal; heat transfer in fluidized beds; pulverized coal combustion; catalytic combustion; cyclonic combustion; coal slagging; electrostatic precipitation of fly ash; freezing of coal; microbial desulfurization of coal; kinetics of coal gasification; fluidized bed gasification; dynamic simulation of coal conversion systems; kinetics of coal liquefaction; hydrogen-enhanced crack growth in high-strength steels; organic coatings for flue gas desulfurization service; weld repair of steam turbine rotors; mechanical properties od cryogenic steels for LNG applications; toughness of pipeline steels; fracture analysis of pipelines; mechanisms of tertiary oil recovery.

Nuclear technology. Instrumentation for reactor safety studies; boiling heat transfer in water-cooled reactors; fracture toughness of reactor steels; static and dynamic fracture toughness of steel welds; microstructural characterization of pressure vessel welds; pressure vessel design, radioactive waste disposal; high-energy particle physics, nuclear physics.

Environmental impact of energy systems. Oil pollution studies in the coastal and wetlands environment; effects of power plant operations on biological life in the New Jersey estuarine region; acid rain; trace metal contamination of aquatic ecosystems.

Conservation and renewable resources. Biological conversion of cellulose to chemicals and fuels; catalysis for alcohols from biomass; energy recovery from municipal solid waste; fuel derived from waste water treatment; energy conservation in the metal-forming industries; instrumentation and analysis of industrial processes; use of computers for process control; development of microprocessors for residential load control; consumer response to peak load pricing; cooling of electric utility generators and high-capacity electric motors; design of cryogenic turbines; instrumentation for HVAC applications; siting of wind-power applications.

Energy economics. Dynamic analysis of energy supply-demand systems; model of an investor-owned electrical utility; peak-load pricing of electricity and natural gas.

Educational Opportunities. The extensive involvement of faculty in energy research has created a wide range of opportunities for graduate studies in energy. Most of the departments in the College of Engineering and Physical Sciences, as well as several departments within the College of Arts and Science and the College of Business and Economics, are active in energy research and offer both masters and doctoral degree programs suitable for studies of energy-related topics.

All degrees are granted by the academic departments and graduate students interested in energy enroll in traditional graduate degree programs in departments of their choice. These students specialize in energy by complementing their programs with a selection of special energy-related courses. They pursue their graduate research in energy areas under the supervision of faculty from the Energy Research Center or from other research centers or academic departments.

Opportunities also exist for students to receive part of their training in industry. With initial support from the National Science Foundation, Lehigh has developed a program in which a graduate student involved in energy can do a research internship in industry under the joint supervision of company research staff and the student's faculty adviser. The Energy Intern Program is individualized: each intership is designed to meet the specific needs and interests of the student, the faculty adviser and the company.

Financial support for graduate students is available through the Energy Research Center by means of fellowships and research assistantships related to sponsored research.

Each year Lehigh faculty members offer a number of special energy-related courses at the undergraduate and graduate levels; many of them are outgrowths of current faculty research. Recent examples include courses dealing with energy economics, the international politics of oil, nuclear reactor engineering, public policy and nuclear power, air pollution, coal catalysis, coal technology, materials for modern energy systems and solar energy.

The Energy Research Center also sponsors an annual seminar series, bringing some of the outstanding people in the energy fields to the campus to speak. Covering a range of topics from economics to energy policy to science and engineering, these seminars provide an opportunity for faculty and students to learn of new developments in energy.

For more information, write to Professor Edward K. Levy, 440 Brodhead Avenue, Lehigh University, Bethlehem, Pa. 18015.

Fritz Engineering Laboratory

Founded in 1909, Fritz Engineering Laboratory is involved in the advancement of knowledge and techniques in the fields of structures, structural mechanics, materials, hydraulics and fluid mechanics and geotechnics.

The laboratory is associated primarily with the department of civil engineering. In addition, there are cooperative research efforts with other departments and with other institutes and universities. Research projects are sponsored by national research councils, through the university Office of Research, and by industry and governmental agencies.

Graduate studies combined with research investigations commenced at Fritz Engineering Laboratory in 1928. A major expansion of the facilities in 1955 was followed by addition of equipment to meet the needs of new research opportunities

The staff consists of faculty members, research associates, research assistants, and supporting technical personnel. The laboratory awards research assistantships and certain fellowships to competent research personnel who are candidates for advanced degrees. Students from departments and divisions such as civil engineering, metallurgy, mechanical engineering and mechanics, and information science are able to take advantage of research opportunities with the laboratory.

Through their work in research programs, individuals are trained for careers in teaching, in research, and in advanced engineering design.

Research activities. The current research divisions indicate present interests and activities of the laboratory staff and include the following:

Fatigue and fracture (brittle failure due to cyclic and impact loading); geotechnical engineering (soil, foundation, rock and pavement mechanics); hydraulics (stream and channel flow, hydrology, sediment transport in pipes and channels); building systems (behavior and strength of building components, frames and over-all systems, problems involved in the design of high-rise buildings, earthquake and wind responses); structural concrete (prestressed and reinforced concrete bridges and buildings); structural connections (welded and bolted joints, composite structures); and structural stability (buckling of plates, beams, columns and frames).

The operations division provides services for laboratory work, and includes an instrumentation group and a computer systems group, the latter maintaining close liaison with the university's Computing Center.

As a result of the research studies conducted by the staff of the laboratory, it has been possible to make basic changes to design procedures and specifications in many specialty fields. The laboratory participates in a world-wide exchange of research information, maintains a library of technical papers appropriate to its fields, and stimulates the publication of papers in technical journals both in this country and abroad.

Educational opportunities. Through the laboratory organization, technical seminars and lectures are presented on current research findings and on new design applications in the various fields of civil engineering and related disciplines.

Courses students select are primarily in their own department. However, to gain a broader understanding, many students choose courses from the departments of biology, chemical engineering, chemistry, civil engineering, geological sciences, industrial engineering, mechanical engineering and mechanics, and metallurgy and materials engineering.

For further information write to the director, Professor Lynn S. Beedle, Fritz Engineering Laboratory 13, Lehigh University, Bethlehem, Pa. 18015.

Center for Health Sciences

The Center for Health Sciences, organized in 1972, is concerned with interdisciplinary research and graduate and postdoctoral training in various aspects of the biomedical sciences and engineering.

The center is comprised of two divisions: the Division of Biological Chemistry and Biophysics and the Division of Bioengineering. Facilities are provided by these divisions for its members, postdoctoral fellows, and graduate students actively engaged in research in the respective areas.

A large part of the research conducted at the center is supported by private and public agencies and all are related to either basic or applied aspects of problems pertaining to human and animal life.

Research activities. The research opportunities and programs of each division are described below.

Division of Biological Chemistry and Biophysics. Interests currently represented in ongoing research include enzyme biochemistry, intermediary metabolism, medicinal chemistry, biosynthesis of organic molecules, the physical basis of surface adhesion in biological systems, clinical chemistry, effects of radiation of nucleic acids, nuclear medicine, radiopharmaceuticals, and biophysics of viruses. Much of the research is being funded from private and federal agencies.

The administrative offices of the division and most of the laboratories are housed in the Seeley G. Mudd Building. The laboratories are well equipped and the major pieces of equipment include infrared, ultraviolet, and visible spectrophotometers, nuclear magnetic resonance instrumentation, mass spectrometers, fermenters, gas and liquid chromatographic facilities, and other allied bio-organic apparatus.

This division has an ongoing liaison program with Hahnemann Medical College and Hospital; clinical aspects of several research projects are being conducted there.

Division of Bioengineering. This unit of the center is concerned with a number of health-related problems that are best resolved by individuals with a background in engineering. Ongoing projects include measuring the rigidity and tension of healthy and diseased blood cells, the mechanics of flow through the mammalian circulatory system, the fracture mechanics of skeletal units, and the development of prosthetic apparatus and implant materials. An interdisciplinary effort is underway in cardiovascular research; the metabolic aspects of regulatory mechanisms are being studied with animal models and computer simulation.

Educational opportunities in The Center for Health Sciences. Graduate students working under the direction of members of various components of the center may satisfy course requirements towards the M.S. and Ph.D. degrees by selecting from the offerings of the departments of chemistry, physics, biology, civil engineering, mechanical engineering and mechanics, as well as other departments.

In addition, the interdisciplinary graduate program in physiological chemistry leading to the master of science and the doctor of philosophy degrees is supported by the Center for Health Sciences, although all of the students are enrolled in the department of chemistry. Students may also pursue graduate degrees in biochemistry, organic chemistry, or molecular biolgoy under supervision of

center faculty members.

In addition to research, the center sponsors symposia as well as annual series of seminars on topics pertinent to its objectives.

For further information write to the director, Professor Ned D. Heindel, Chandler-Ullmann Hall 17, Lehigh University, Bethlehem, Pa. 18015.

Center for Information and Computer Science

The Center for Information and Computer Science is an interdisciplinary center that supports research and development activities in computer-based information systems. Information technology, which includes the means for storing, analyzing, retrieving, and transmitting information and knowledge is one of the great scientific and engineering adventures of all time.

A major interest of information science is the problem of information transfer, which involves the communication of recorded information among originators, processors, and consumers. Information science has emerged as a response to this problem, and seeks to establish an organized body of knowledge based on explanatory principles governing the conditions under which events occur concerning the generation, transmission, and use of information.

The significance of establishing reliable principles of information transfer is directly related to the rapidly increasing importance of information-handling activities in society. Some 60 percent of the United States labor force is already involved in the information sector, and the percentage is increasing. This situation has been heavily influenced by the truly remarkable advances made in computers and communications technology, allowing processing of an increasing volume of material and a rapidly increasing variety of applications.

Information science and computer science are evolving disciplines with many common interests. One of the most important is to know how to use newly emerged and still-developing computer/communications technology in coping with problems that have affected society for a long time, and that are receiving increased attention. These problems are likely to become even more prominent as society shifts from industrial production to service activities.

Early recognition of the so-called "information explosion" led to the formation of the Center for Information Science in 1962 as a division of the university libraries. It was reorganized in 1967 as an independent center for research into information retrieval and for the development of information systems. A significant milestone was the design, development, and operation of the world's first information retrieval system providing on-line interactive access to the computerized data base of *Engineering Index*. The system is known as Leadermart because of its affiliation with the Mart Science and Engineering Library.

In 1978, the scope of the center was broadened to include computer science. The combination of the two activities and their substantial areas of common interest provide a platform for a wide variety of research projects. The center works closely with industry in projects of mutual interest.

Research activities. Research facilities in CICS include five TERAK minicomputers, and Apple II microcomputer, development boards for Motorola and Texas Instruments microcomputers, and remote computer terminals to access university computer facilities. The research and development activities of the center reflect current interests of staff members and include:

Fundamental research in information science. Studies in the structure of information; syntactical structures; semantic content, hierarchical retrieval structures; formal theories of information retrieval; the logical complexity of retrieval schemes; character recognition; pattern recognition; theories of information retrieval; formal grammars; computational and mathematical linguistics.

Fundamental research in computer science. Design of algorithms; properties of software; graph theory; theory of formal languages; automata theory; data and information structures; discrete mathematical structures; recursive function theory; computability and solvability; structured programming; compiler design; operating systems.

Behavioral research. Interfaces between people and information systems, learning and memory; human factors; psycholinguistics; cognitive processes.

Applied research in information and computer science. Microprocessors in information systems; downsizing of information systems; firmware development; office automation; decision support systems for management; solution of communications problems; analysis of management information problems; library automation; medical information systems; simulation models of large-scale science information networks; management information systems; design of data base management systems; fact retrieval; new techniques of full text searching; interactive question-answering systems; knowledge transfer systems; computer-communication networks; systems analysis; artificial intelligence; numerical processing; communication protocols; scheduling.

Education opportunities. The Center for Information and Computer Science is closely affiliated with the division of computing and information science in the department of mathematics (see Section V). Programs leading to the B.S., M.S., and Ph.D. degrees are offered by the division. Opportunities exist for both graduate and undergraduate students to participate as research assistants and project assistants on sponsored research activities. Such activities provide graduate students with dissertation and thesis topics, as well as the use of computer terminals, microcomputers, minicomputers, and other facilities.

Seminars, short courses, and other educational programs are conducted periodically.

For information, contact the director, Professor Donald J. Hillman, Center for Information and Computer Science, Mart Library 8, Lehigh University, Bethlehem, Pa. 18015.

Center for Marine and Environmental Studies

The Center for Marine and Environmental Studies is a multidisciplinary research organization with the primary purpose of fostering research opportunities in the broad fields of environmental science and technology, coastal engineering, estuarine ecology, aquatic chemistry and environmental studies. Established in 1962 as the Marine Science Center, the scope was broadened and the name changed in 1967.

The center staff includes faculty and graduate students from the departments of biology, chemistry, civil engineering, geological sciences, mechanical engineering and mechanics, physics, chemical engineering, economics, social relations and urban studies.

Effective utilization of the resources of the environment and their protection requires the cooperation of many scientific and engineering disciplines. Practical solutions will most likely be achieved for the many critical environmental problems facing the world through a combination of engineering and scientific talent, coupled with economic and political decision making. An environmental scientist or engineer needs an unusually broad background in many disciplines, as environmental problems are invariably cross-disciplinary in nature, i.e., solid, hazardous wastes.

Research activities. A broad spectrum of research activities is included within the scope of the center. Although much of the research is done in facilities of various academic departments, CMES has laboratories in Williams Hall (environmental biology and marine sedimentology), in Chandler-Ullmann Hall (environmental engineering, estuarine ecology, environmental geotechnology), Fritz Laboratory (water and waste-water analysis and treatment), and an off-campus marine station near Stone Harbor, N.J. (see listing below for The Wetlands Institute). Lehigh University is a member of the New Jersey Marine Sciences Consortium and has access to their marine facilities, laboratories, and boats.

Current research activities reflect the interests of the

present center staff, and include: physiologic response of marine invertebrates to sublethal pollutants; reproductive strategies of shipworms in coastal thermal effluents; coastal salt marsh food-chain relationships; marine vertebrate behavior studies; biochemistry of marine bacteria; near-shore sedimentation; oceanic sedimentation on the continental slope and rise; beach sedimentation processes; control, management and treatment of toxic and hazardous wastes; waste soil interactions; effects of industrial and municipal pollution on surface and subsurface water resources; advanced wastewater treatment methods; improved control of treatment plants through automation; acid rain; economics of resource development and environmental protection; and utility planning and management.

Educational opportunities. Graduate students may undertake thesis or dissertation research under the supervision of faculty associated with the center, who are members of an academic department; all courses are taught within academic departments. The program of courses to meet the student's special field of interest and to satisfy departmental and Graduate School requirements is determined by consultation with the academic department chairperson or a special departmental faculty committee.

Environmental engineering and coastal engineering courses are offered by the civil engineering department. Courses related to environmental studies and marine science are offered by the departments of biology, chemistry, chemical engineering, civil engineering, geological sciences, economics, and government.

Further information concerning educational opportunities may be obtained by writing to the chairperson of the appropriate academic department, or to the center director, Professor Irwin J. Kugelman, Chandler-Ullmann Hall 17, Lehigh University, Bethlehem, Pa. 18015.

Materials Research Center

The Materials Research Center was established in 1962. Currently, approximately 140 persons, including graduate students, research associates, and faculty members representing science and engineering departments, are engaged in research pertaining to materials science and engineering.

The fundamental objectives of the Materials Research Center are to encourage interaction among the science and engineering disciplines with an interest in materials and to promote interdisciplinary research activity and interdepartmental educational opportunities. To achieve these objectives, the center seeks to establish a climate in which faculty members, research scientists, postdoctoral associates, and graduate assistants develop an awareness of materials; arrange for facilities and space required to conduct interdisciplinary research; guide the search for new materials by encouraging fundamental research and new approaches to materials problems; and assist in developing educational opportunities in materials—in particular, interdisciplinary graduate programs devoted to training for research in materials.

The center also conducts the Materials Liaison Program. Founded in 1963, this program promotes the interchange of knowledge between the materials community at Lehigh and engineers and scientists in industry and government. The program conducts seminars on materials research, special lectures and workshops on items of current interest; consults on materials problems and research; distributes master of science and doctor of philosophy theses and abstracts of materials research; and sponsors seminars with outstanding invited speakers.

The staff consists of members of the departments of chemistry, chemical engineering, electrical and computer engineering, mechanical engineering and mechanics, metallurgy and materials engineering, and physics. Members of other departments and centers frequently are involved in cooperative programs. Communication with these associated units is achieved through the Materials Research Council, which is composed of senior faculty members from all of the engineering departments as well as from the department of geological sciences and appropriate research centers. The council serves in an advisory capacity as well.

Research Activities. The present organization of the Materials Research Center includes five laboratories: the electronic materials laboratory, located in the Sherman Fairchild Laboratory; the electron optical laboratory, located in Whitaker Laboratory; and the ceramics research, mechanical behavior, and polymer laboratories, all located in Coxe Laboratory. Current interdisciplinary research activities include:

Electronic materials. Preparation and properties of materials for solid-state devices; characterization of metal oxide films using optical and electrical methods emphasizing metal-insulator-semiconductor structures; defect structure and impurity interactions in amorphous and crystalline materials in both bulk and thin-film form; interfacial segregation and phase formation in metal-oxide systems.

Electron Optics. Characterization of fracture surfaces in polymers and steels by scanning electron microscopy; x-ray microanalysis of extraterrestrial materials, ferrous alloys, geological materials and ceramics using the electron probe microanalyzer; transmission and scanning transmission electron microscopy studies of grain boundaries in oxides; discontinuous precipitation in non-ferrous alloys; low-temperature phase transformations in iron materials; inclusions in weld structures of ferrous alloys; and glass metal reactions in lunar samples.

Ceramics. Deformation mechanisms, including creep and hotpressing; sintering studies and additive effects; microstructural characterization of ceramic materials; fast-ion conductors; defect chemistry and electrical properties of ternary oxides.

Mechanical behavior. Effect of polymer chemistry and molecular structure on fatigue crack propagation (FCP); test frequency sensitivity and fatigue fracture micromechanisms in polymer solids; fracture characteristics of bridge steels; fatigue of weldments; corrosion fatigue crack propagation; metallurgical aspects of FCP in ferrous and non-ferrous alloys; fracture mechanism studies by transmission and scanning electron microscopy.

Polymers. Fatigue crack growth and relaxation processes in engineering plastics and composites; structure, morphology and mechanical behavior of interpenetrating polymer networks; thermosetting resins; vinyl polymers; polymers based on renewable resources; permeability and mechanical behavior of membranes, coatings, and filled polymers; novel polymer concrete systems.

Educational Opportunities. This center facilitates programs of study and research that cross the traditional boundaries of science and engineering curricula, providing a fundamental, broad approach to the field of materials science and technology.

Graduate students participating in the center's program usually receive master of science or doctor of philosophy degrees in the academic discipline of their choice, i.e., chemistry, physics, metallurgy and materials engineering, electrical engineering, etc.; or in an interdisciplinary program such as polymer science and engineering. However, they are expected to pursue course work related to a broader understanding of materials and to conduct research on an interdisciplinary materials problem in one of the center's five laboratories.

Financial support for graduate students is available through the Materials Research Center by means of research assistantships related to sponsored research programs.

For further information write to the director, Professor Donald M. Smyth, Coxe Laboratory 32, Lehigh University, Bethlehem, Pa. 18015.

Center for Social Research

The Center for Social Research is a multidisciplinary organization designed to stimulate and conduct research involving the social and behavioral sciences, particularly in relation to technology.

Several disciplines are involved in the activities of the center: economics, political science, psychology, sociology, anthropology, accounting, and international relations. Through externally funded projects, the center also cooperates with the university's other research centers. Projects are conducted in cooperation with several science and engineering departments.

Founded in 1965 as the Center for Business and Economics, the focus of the center was later broadened, and the name changed to the Center for Business, Economics, and Urban Studies. The center's early activities included research on economics and business forecasting, and on transportation problems. The change to include urban studies broadened the center's scope to encompass the disciplines of political science, sociology, and history. In 1972, the center's scope was further broadened to include behavioral science and international affairs, and the present name was selected as more accurately reflecting this broadened focus.

Interdisciplinary research. The social perspective of the center's research is interdisciplinary in nature and is relevant to the community outside the university—local, regional, national, and international. Many research activities are based on a cooperative university-community relationship through which the research goals of the center are achieved and community needs met. Interdisciplinary research activities of the center are currently being conducted in the following areas:

Aging. Members of the departments of psychology, economics, social relations, government, English, and the School of Education participate in the program on aging. The wide variety of research interests include economics and politics of service delivery, management aspects of organizations that serve elderly individuals, public and private pension systems, psychological aspects of aging, design of housing for the elderly, family and marital relations, and health and education in later life.

Recently completed projects have examined relationships between apportionment of service agency budgets and agency managerial objectives, inclusion of elderly persons in college courses, and reactions of long-term residents to neighborhood change. Current research includes a study of cognitive functioning in the later years. The program is moving toward a coordination of interests in several specific areas particularly service delivery, housing, and health, and the implications of attitudes to and stereotypes of various age groups for public policy and intergenerational relations.

Behavioral Research. Members of the departments of government, psychology, social relations, and economics participate in the behavioral research program. Research interests include family dynamics and child-rearing practices, small group processes, environmental and community psychology, social motivation, and social attitudes.

The relationship between family dynamics and child-rearing has been the focus of several center studies. One study has examined family style and the ability to cope with the stresses of family life. A second study has examined the effects of a multidimensional program of services to families characterized by inadequate child-rearing practices. A current study is assessing the effect of family dynamics and child-rearing practices on children's development of social competence. These studies have been particularly concerned with factors that influence the quality of the parent-child relationship.

Program evaluation. Members of the departments of social relations, economics, and accounting participate in research to evaluate the effects of service-oriented programs. Particular emphasis is on improving program evaluation methodology. Current research interests include evaluation of programs related to social service delivery and energy conservation. Research is also being conducted on the effect of aspects of compensatory education programs and of education pertaining to energy conservation.

Urban technology. The urban technology program includes faculty from the departments of civil engineering, industrial engineering, social relations, and government, and from the College of Business and Economics. The primary focus of the programs is an integrated, interdisciplinary approach to current urban problems. The program serves as a visible liaison point for both city officials and university researchers.

Current or recently completed research efforts include energy conservation and cost-reducing methods for local government, the economic and technical feasibility of resource recovery, methane gas recovery and usage, storm water management, geocoding, computer mapping, information systems, vehicle maintenance scheduling and municipal productivity. Many of these activities began as a part of the Allentown, Pa., Urban Observatory, originally funded by the U. S. Department of Housing and Urban Development through the National League of Cities. The projects are now carried on by the city of Allentown. Research is also underway to assess various factors affecting water quality. Internationally, research is underway on various aspects of centrally planned Eastern European economies. The primary thrust of the present research are macroeconomic evaluations of resource allocations made by planners in these economies.

Educational opportunities. All faculty associates of the Center for Social Research are members of university academic departments and teach in their respective departments. Graduate and undergraduate students from these departments are active in the center's research. The departments in most cases offer graduate degrees at the master's level; a few offer the doctorate.

Undergraduate training is conducted in the form of independent research projects and research internships.

Graduate training is conducted by the center in cooperation with those social and behavioral science departments at Lehigh that offer graduate programs. The College of Business and Economics offers the M.B.A. as well as the Ph.D. in business and economics. The government department offers the M.A., M.P.A., and D.A. degrees. The psychology department offers the M.A. and D.A. The social relations department offers the M.A. degree in each of three areas—anthropology, social psychology, and sociology. The social relations department also offers a masters-level concentration in health and aging. For further information on these programs, consult the relevant department description.

Financial assistance to graduate students is available through graduate research assistantships provided by research grants and contracts to the center.

For further information, contact the director, Roy C. Herrenkohl, Center for Social Research, 10 West Fourth Street, Bethlehem, Pa. 18015.

Center for Surface and Coatings Research

The Center for Surface and Coatings Research includes within its structure the National Printing Ink Research Institute and six laboratories: catalysis laboratory, colloid laboratory, color laboratory, corrosion laboratory, environment-sensitive fracture laboratory, and surface analysis laboratory. The founding of the center in 1966 was an acknowledgment of the fact that surfaces and coatings are of basic scientific interest and of technological importance. The subject area provides a good meeting place for basic and applied science.

Twelve faculty members from the departments of chemistry, chemical engineering, mechanical engineering and mechanics, and metallurgy and materials engineering are associated with the center. They have offices in Sinclair Laboratory. Three research scientists with backgrounds in chemistry and metallurgy are active in the center's research. The center is interdisciplinary in outlook and in fact.

Financial support for the center comes largely from research projects contracts with various industries and governmental agencies. Opportunities for cooperative sponsorship are provided by the center's liaison programs, whereby nonproprietary research is performed in areas of specific interest to the participating sponsors.

The center is well equipped with specialty instrumentation needed for advance research in its field. Sinclair Laboratory houses equipment for experimental studies employing flash desorption, Mossbauer spectroscopy, Auger spectroscopy, X-ray photoelectron spectroscopy, electron spectroscopy for chemical analysis, nanosecond fluorescence spectroscopy, ellipsometry, computerized spectrophotometry, microelectrophoresis, and continuous electrophoresis.

Other specialty equipment includes microbalances, testing machines for studies of environment-affected crack growth, gas adsorption and heat of immersion apparatus, wetting balances, apparatus for determining rheological properties, and apparatus for the preparation of reproducible dispersions and films.

Research activities. The center's research program includes a broad range of topics vital to modern science and technology.

Some of the active topics are: solid-state chemistry of catalysts; catalytic oxidation of methane; mechanisms of catalytic reactions and development of new catalysts; wetting of multiphase systems; monodisperse oxides, characterization of surfaces; microelectrophoresis and continuous electrophoresis; electrophoresis under microgravity conditions; computerized color matching; estimation of color differences; color constancy and metamerism in coatings; light scattering in microvoids; Mossbauer spectroscopy of surfaces; erosion and wear, chemical composition of surfaces; passivity and corrosion inhibition; Auger spectroscopy; chemistry of fracture surfaces, hydrogen embrittlement; environmentally affected crack growth; high-temperature corrosion; adhesion of coatings; corrosion under coatings; water-based coating; electrical properties of coatings; polymer surfaces; rate of drying of latex films; preparation of latexes by direct emulsification; particle size determination by hydrodynamic chromatography; rheology in non-Newtonian fluids; adhesion and flow of fluids in porous substrates; photovoltaic effects in small particles; and chemistry and metallurgy of glavanized steel.

The *Journal of Colloid Sciences* and *Advance in Colloid and Interface Science* are edited by Albert C. Zettlemoyer, University Distinguished Professor of Chemistry and an associate of the center.

Educational Opportunities. The center is a facility in which graduate students undertake dissertation research leading to the M.S. or Ph.D. degrees in existing science and engineering curricula. Pertinent courses are offered in the departments of chemistry, chemical engineering, physics, mathematics, biology, metallurgy and materials engineering, and mechanical engineering and mechanics. A formal program in polymer science is active.

Potential and current graduate students whose interests are consistent with the center's objectives are welcome to associate with the research program and to avail themselves of the experimental facilities. Research assistantships are available. Since research topics are selected by mutual agreement, interested students are encouraged to explore research opportunities with the center's director.

The center's research also forms the basis of continuing educational programs designed primarily for industrial personnel. The conference center in Sinclair Laboratory accommodates the special seminars and short courses that are held periodically. Recent course topics include surface analysis, printing ink technology, emulsion polymerization, computer formulation of colorants, and paint removal.

The center provides opportunities for resident postdoctoral studies and for visiting scientists.

For further information, write to the director, Professor Henry Leidheiser, Jr., Sinclair Laboratory 7, Lehigh University, Bethlehem, Pa. 18015.

University Institutes

There are nine institutes at Lehigh University. All but one were established since 1970; the newest, the Institute for Robotics came into being in 1982.

The others are the Emulsion Polymers Institute, the Institute of Fracture and Solid Mechanics, the Lawrence Henry Gipson Institute for Eighteenth-Century Studies, the Institute for Metal Forming, the National Printing Ink Research Institute, the Institute for Research and Development in Education, the Institute for Research and Development in Education, the Institute of Thermo-Fluid Engineering and Science, and The Wetlands Institute.

Staff members of these institutes are listed in Section VI.

Emulsion Polymers Institute

The Emulsion Polymers Institute, established in 1975, provides a focus for graduate education and research in polymer colloids. Formation of the institute constituted formal recognition of an activity that had grown steadily since the late 1960s.

The institute has close ties with polymer and surface scientists in the Center for Surface and Coatings Research and the Materials Research Center and the departments of chemical engineering and chemistry.

Polymer colloids or polymer latexes, as they are more commonly called, are finely divided polymer particles that are usually dispersed in an aqueous medium. Important products produced and utilized in latex form include synthetic rubber, latex paint, adhesives and paper coatings. The small particle size of typical latexes make their colloid properties as important as the polymer properties for a number of applications. Hence, the study of emulsion polymers is an interdisciplinary activity.

Research activities. Emulsion polymers research includes a broad range of problems in the areas of preparation, modification, characterization, and application of polymer latexes. Most commercial polymer latexes contain a number of important ingredients; some in only small quantities.

Research programs at Lehigh are aimed at understanding the function of recipe components during preparation and application of the latexes. The research projects are a blend of fundamental and applied efforts as well as a mixture of theoretical and experimental problems.

Significant research support for institute activities is obtained from industrial organizations through their membership in the Emulsion Polymers Liaison Program. Hence some considerable effort is made to relate the research results to industrial needs. Consequently, graduates can find excellent opportunities for employment.

Educational opportunities. Graduate students in the institute undertake dissertation research leading to the master of science or doctor of philosophy degrees in existing science and engineering curricula or in the polymer science and engineering program.

Programs of study for individual students are designed to meet the student's interests, the requirements of the appropriate academic department, and the student's dissertation committee. Considerable flexibility is permitted in the selection of courses and a research topic.

Faculty members of the institute are involved in teaching normal university courses and continuing education courses for industrial personnel. The annual one-week short course, Advances in Emulsion Polymerization and Latex Technology, typically attracts about 100 industrial participants and 20 Lehigh students. This course is an important mechanism for developing meaningful interactions between institute staff and students and industrial scientists and engineers. Educational and research opportunities exist for postdoctoral students and visiting scientists as well as resident graduate students.

For further information write to Professor John W. Vanderhoff or Professor Mohamed S. El-Aasser, Sinclair Laboratory 7, Lehigh University, Bethlehem, Pa. 18015.

Institute of Fracture and Solid Mechanics

The Institute of Fracture and Solid Mechanics was established in the fall of 1970 to enable faculty members and students within the university to participate in research relevant to fracture and solid mechanics on an interdisciplinary basis.

An area of special interest to the institute has been in fracture mechanics, which deals with the study of structural and material sensitivity to flaws. Such flaws can seriously affect the design and strength of ships, aircraft, automobiles, bridges and buildings. In the design of nuclear power plants, the incorporation of the fracture mechanics concept of safety in the presence of flaws is required. In addition, fracture mechanics is finding application in such areas as bone fracture, environmentally accelerated cracking of pavements and structural members, the fracture of rocks, and erosion of materals by solid or water particle impingement.

The institute centralizes many activities in the field of solid and fracture mechanics. These activities include: expansion of research capabilities to include the application of concepts of fracture mechanics to geology (rocks), medicine (bones), and composite materials; editing books on timely subjects in fracture and solid mechanics; compilation and collection of written materials to establish and maintain a special library of fracture mechanics; planning of conferences on fracture and solid mechanics; offering short courses and seminars on special topics; conducting liaison programs with industry and government agencies.

Research activities. There are several research programs being conducted in solid and fracture mechanics, sponsored by industry and governmental agencies. They include:

Fracture mechanics. Analytical: stress analysis of engineering structures weakened by flaws; spherical and cylindrical shells with mechanical imperfections; crack extension in viscoelastic and rate sensitive materials; thermoelastic analysis of crack problems; heat generation at the crack tip region in metals; vibration and impact of solids containing cracks; three-dimensional analytical and finite element studies of surface and through cracks; fracture behavior of layered and fiber-reinforced composites; elastic-plastic solutions of crack problems.

Experimental: static and dynamic fracture roughness testing of metallic, nonmetallic and composite materials; crack-extension resistance curve measurements for aluminum and titanium alloys and steels; glass-to-rubbery transition temperature in viscoelastic materials; velocity measurements of running cracks; fatigue crack propagation in pressurized shells and shells under membrane load; combined loading (biaxial, tension-bending, etc.) of thin plates with cracks; photoelastic studies of stress distribution in cracked and composite bodies; environmental effects on crack propagation under static cyclic loads; fatigue crack propagation under programmed loading; gaseous hydrogen embrittlement.

Solid mechanics. Analytical and numerical methods of analysis: conformal mapping technique applied to potential solutions; two-and three-dimensional asymptotic expansions near geometric discontinuities; integral transform solutions leading to Fredholm integral equations; singular integral equations with generalized Cauchy kernels; application of the Chebyshev and Jacobi polynomials; methods based on the Gauss-Jacobi quadrature formulas; special applications of numerical treatment and finite elements to continuum problems involving singularities; convergence of finite element solutions for continuum mechanics problems.

Plates and shells; development of advanced plate and shell theories; load-deflection and instability behavior of elastic and plastic shells of revolutions; composite and sandwich shells subjected to static and dynamic loadings; dynamics of magnetoelastic shells.

Educational Opportunities. Students interested in fracture and solid mechanics should refer to course offerings in the departments of mechanical engineering and mechanics, metallurgy and materials engineering, civil engineering, chemistry and biology.

For further information write to the director, Professor George C.M. Sih, Packard Laboratory 19, Lehigh University, Bethlehem, Pa. 18015.

Lawrence Henry Gipson Institute for Eighteenth-Century Studies

The Lawrence Henry Gipson Institute for Eighteenth-Century Studies, established in 1971, serves as a memorial to one of America's most distinguished scholars, and long-time member of the faculty at Lehigh.

It helps to support the research activities of the Lehigh community of humanists and social scientists interested in developing a further understanding of the period of history epitomized in Professor Gipson's monumental life work, *The British Empire Before the American Revolution* (15 volumes, written from 1936 to 1970). The professor won the Pulitzer Prize for Volume 10.

Through its council, the Gipson Institute awards research grants and fellowships from the income of its endowment, a fund made possible by Professor Gipson's bequest of his entire estate to Lehigh. To further the scope of the original endowment, the council of the institute seeks additional support by promoting research and other programs related to the eighteenth century.

Research activities. The income from the endowment of the Gipson Institute, and other funds, provide faculty research grants to defray travel cost, microfilming, and other such expenses; graduate student grants to help support deserving students during their dissertation year; internal seminars to bring together the eighteenth-century interests of faculty and graduate students and to stimulate interdisciplinary research activities. These seminars are broad in scope and include faculty from neighboring institutions. Interdisciplinary graduate courses in eighteenth-century studies provide students, who normally concentrate on one discipline, with a grasp of other significant developments and an understanding of the rich cultural and intellectual milieu of the eighteenth century. Such courses stress the interrelationship of history, politics, literature, fine arts, philosophy, psychology, and the sciences.

Annual symposia honor Professor Gipson, involving distinguished scholars in eighteenth-century studies to lecture and also discuss opportunities for further scholarly exploration. The institute also provides additional research resources for the library, as well as faculty and student fellowships for the pursuit of research in an eighteenth-century topic.

Educational opportunities. Among the academic departments involved in eighteenth-century studies are English, government, history, modern foreign languages and literature, art and architecture, music, philosophy, psychology, and social relations.

For further information, write to the coordinators, Professor James S. Saeger, department of history, or Jan Fergus, department of English, Maginnes Hall 9, Lehigh University, Bethlehem, Pa. 18015.

Institute for Metal Forming

The Institute for Metal Forming, sponsored by the department of metallurgy and materials engineering, was established in 1970 to teach the principles and applications of metal-forming technology to graduate and undergraduate students; to provide instruction and equipment for graduate research in metal-forming processes; and to assist industry with solutions to problems in metal forming.

Metal-working processes are analyzed mathematically, usually involving the computer. The results of the analyses are checked and refined by comparison with experimental data obtained in the fully instrumented metal-forming laboratories that are part of the institute's facilities.

In addition, an important part of the effort of the institute is the preparation of educational programs using the latest audio-visual techniques. These programs are used in the classroom and in institute-sponsored seminars on campus and at industrial facilities.

Long-range planning, together with major equipment acquisitions and construction, is supported by university funds, federal funds, and an industrial consortium.

Research activities. Current research areas include: hydrostatic extrusion; pressure-induced ductility; flow through converging conical dies; effect of holes, inclusions and pressure on tensile properties; friction measurement; cladding and forming of composite materials; forming of polymers; deep drawing, impact extrusion and ironing; powder consolidation.

Educational opportunities. Students interested in metal forming should refer to course descriptions in Section V for metallurgy and materials engineering and mechanical engineering and mechanics. In addition, the institute offers special informal seminars and lectures for graduate students.

For further information write to the director, Professor Betzalel Avitzur, Whitaker Laboratory 5, Lehigh University, Bethlehem, Pa. 18015.

Institute for Research and Development in Education

The Institute for Research and Development in Education was established in 1978 to encourage research in areas of education in which students and faculty have specific interests. Typical services provided include identifying and contacting funding sources, conducting literatures searches, assisting with budget preparation, and other research support.

The institute acts as a liaison between the researcher and external agencies such as the U.S. Department of Education, the U.S. Department of Health and Human Services, state departments of education, intermediate units, and school districts. Agencies receive technical assistance in the areas of training, program design, needs assessment, evaluation, and computer applications.

The institute is associated primarily with the department of administration and supervision, instruction and curriculum, and human development in the School of Education, but it also cooperates with other departments, centers and institutes.

Research activities. The efforts of the institute are aimed at developing faculty resources to conduct research, training, and evaluation programs in areas of education associated with faculty interests in the three aforementioned departments. These interests include but are not limited to: school law; organizational behavior; school financing; cognitive development of children; language development; personality development; learning disabilities; psychometrics; minority assessment; counseling; biofeedback; reading; philosophical, sociological and historical foundations of education; violence and vandalism in schools; and the education of institutionalized populations.

Research in these areas is both theoretical and field-based. Its fundamental intent is to help educators deal with the problems they and their students face in the school and community.

Educational opportunities. Graduate students at both the masters and doctoral levels are encouraged to participate in faculty research.

For information, write to the director, Professor Raymond Bell, Institute for Research and Development, School of Education, Lehigh University, 526 Brodhead Avenue, Bethlehem, Pa. 18015.

Institute for Robotics

The Institute for Robotics was established in August, 1982, to foster interdisciplinary education and research related to industrial robotics; to draw on the various disciplines for which pertinent robotics-related problems exist; and to encourage and support the development of undergraduate and graduate courses in industrial robotics. The creation of the Institute for Robotics is a formalization of the ongoing activity in industrial robotics at Lehigh since the late 1970s. Over fifteen faculty members from five departments in the College of Engineering and the College of Arts and Sciences are performing research in robotics or in robotics-related areas.

The institute serves a dual role of fostering educational programs and providing research facilities and opportunities at both undergraduate and graduate levels. As a first step, the institute is setting up a robotics laboratory to be used as a teaching vehicle in support of courses. The laboratory will be equipped with several teaching robots with micro-personal and computer control systems for experiments in industrial robotics. In addition to the teaching robots, the institute is gathering equipment and software to set up a manufacturing cell, and provide the facilities for robotics research in such areas as welding, assembly, flexible manufacturing systems, and the interface of robots with machine tools and materials handling systems.

Although the institute is still in formation stages at the time of this printing, several hundred thousand dollars-worth of gifts to the institute from Lehigh's industrial affiliates have been identified. In addition, the institute will work closely with the CAD/CAM program.

Research interests. Members of the institute have research interests in a wide variety of areas including the following: robot programming languages, operating systems, and simulation; the design and analysis of robot manipulators under static and dynamic conditions; distributed control architecture for robots and factory systems; control of sensors and the integration of sensors to robots systems; pattern recognition, image processing, and voice processing; the link between robots and CAD/CAM systems to use common data bases as well and to develop computer assisted robot programming using graphic techniques; simulation of robots and manufacturing cells; the interface between robots and other components of the factory floor, and the connection to factory control systems; and the design of special purpose and articulated hands for robot applications.

Although the institute is a new entity, new courses are being developed and several undergraduate senior projects, master thesis and Ph.D. dissertations are already underway. Students interested in the Institute for Robotics are encouraged to contact the institute director directly for an up-to-date profile of institute courses, research opportunities, and activities. Write Professor Roger N. Nagel, Packard Laboratory 19, Lehigh University, Bethlehem, Pa. 18015.

Institute of Thermo-Fluid Engineering and Science

The Institute of Thermo-Fluid Engineering and Science, established in 1978, provides a focus for research and educational activities in fluid mechanics, thermodynamics, and heat transfer.

This institute seeks to consolidate the substantial ongoing research effort in these fields, to aid in the further development of such research, and to facilitate the utilization of this interdisciplinary strength in the university's educational programs.

Currently twenty-one full-time faculty and staff from the departments of chemical engineering, mechanical engineering and mechanics, and physics are among the institute members. Graduate students and undergraduates, as well as part-time and visiting staff members, join in the institute's activities.

Research facilities for thermo-fluids programs are based in the College of Engineering and Physical Sciences. Among the facilities available are laboratories for experimental investigations of fluid mechanics, gas dynamics, turbulent structure, solid-gas fluidization, boiling heat transfer and two-phase flow, refrigeration and heat pump systems, internal combustion engines, radiation and optical measurements, unit operations, and control dynamics. The university's Computing Center as well as various minicomputers are available for use in analytical computations.

The institute also conducts the Thermo-Fluids Liaison Program, to promote the interchange of knowledge between the researchers at Lehigh and the engineers and scientists in industry and government. In cooperation with companies participating in the liaison program, the institute's staff members seek to apply their specialized

capabilities in thermo-fluids to current industrial and governmental engineering and scientific problems.

Research activities. The institute's staff members are involved in three interrelated areas: fluid mechanics, heat transfer and thermal science, and applied thermodynamics and modeling.

Combining experimental investigations with theoretical analyses, the researchers seek to understand and quantify the phenomenological mechanisms governing thermo-fluid processes. This knowledge is then brought to bear on relevant engineering problems of current concern in such applications as energy conservation, power production, coal conversion, aerodynamics, weather modeling, and nuclear energy.

The institute's current research program includes more than fifteen grants sponsored by industry and various governmental organizations. A wide spectrum of subjects are under investigation, including research on flow-induced vibrations, unsteady turbulent flows, solar and wind energy measurements, coherent turbulent boundary layer structures, blade flutter in compressors and fans, stochastic optimal control, application of finite elements for weather modeling, colloid size distributions by hydrodynamic chromatography, centrifugal fluidized combustion of coal, heat transfer in fluidized beds, heat pump systems, two-phase flow instrumentation, boiling heat transfer and two-phase flows, and nuclear reactor thermal safety.

Educational opportunities. Formal courses in fluid mechanics, heat transfer, and thermodynamics are offered in the College of Engineering and Physical Sciences. Institute staff members regularly teach both undergraduate and graduate courses in the departments of mechanical engineering and mechanics, chemical engineering, and physics. Undergraduates can select a program of study, in consultation with their adviser, with emphasis on thermo-fluid sciences by elective choices among the departmental offerings. A formal minor program in fluid mechanics is available. Graduate studies leading to the M.S. or Ph.D. with concentration in thermo-fluids are available in the three departments.

Participation by both undergraduate and graduate students in the thermo-fluids research activities is encouraged. Many undergraduates participate as individuals or as groups in term projects under the supervision of institute faculty members. This provides an opportunity for interested students to obtain first-hand experience in pioneering thermo-fluids research. The research programs directed by institute staff members also provide support for graduate research assistantships, enabling selected graduate students to pursue their education and research in thermo-fluids on either a part-time or full-time basis.

In cooperation with various academic departments, the institute sponsors seminars by both staff specialists and by invited speakers from other institutions. These seminars are open to the university community, liaison program participants, and to engineers and scientists from neighboring industries. The institute anticipates organizing topical meetings, workshops, and short courses on specialized subtopics within the over-all discipline. Meeting topics will be selected to reflect ongoing research activities of the staff members and contemporary engineering concerns.

For information regarding the Institute of Thermo-Fluid Engineering and Science, write to the director, Professor John C. Chen, Whitaker Laboratory 5, Lehigh University, Bethlehem, Pa. 18015.

National Printing Ink Research Institute

The National Printing Ink Research Institute (NPIRI) was established at Lehigh in 1946 to carry out fundamental research for the printing ink industry. It is Lehigh's oldest research institute.

In 1966, NPIRI was incorporated into the newly formed Center for Surface and Coatings Research because its activities formed an integral part of the center's area of interest. In 1970, NPIRI moved with the center into Sinclair Laboratory, which was built in large part with contributions from the printing ink industry.

The National Printing Ink Research Institute carries out fundamental research in its areas of specialization, i.e., application of the principles of colloid, surface and polymer chemistry to the broadest aspects of printing ink and paper, as well as to the printing process itself. Financial support comes principally from research contracts and grants.

Research activities. NPIRI's traditional areas of research are dispersion of pigments, rheology of printing inks, surface chemistry of lithography, printability, test methods, and instrumentation.

More recently, its research interests have expanded to include computer color-matching, safety and health aspects of printing inks, optical properties of ink films, recycling of wastepaper, and ultraviolet light-cured inks.

Its laboratories are equipped with proof presses and test instruments to carry out work in these areas. Of particular interest is the color science laboratory, which is equipped for all types of color measurement, and the printability laboratory, equipped to handle most printing problems.

Educational opportunities. The institute offers opportunities for graduate study leading to the M.S. and Ph.D. degrees. Its graduate students are drawn from the various academic departments and disciplines, e.g., the department of chemistry, chemical engineering, psychology, and polymer science and engineering.

NPIRI also offers undergraduate research opportunities, such as these subjects tailored to individuals or programs involving several students. The 1974 National Science Foundation summer project on recycling of wastepaper, which involved six undergraduates, is an example.

Students who are interested in the institute's areas of research specialization are welcome to associate with its program and to use its experimental facilities. Research topics are selected by mutual agreement between the student and the faculty adviser. Prospective students are encouraged to explore these opportunities with the institute's director.

NPIRI's other educational activities include an annual summer course in printing ink technology and a short course in physics and chemistry of printing ink as well as meetings on special topics, e.g., Rheology of Printing Inks, Ecology in the Graphic Arts Industry, and Raw Materials Supply in the Printing Ink Industry. Other activities include the Test Methods Index, a compilation of test data applied to inks and coatings, and Volumes I, II, and III of the Raw Materials Data Handbook, a compilation of the physical, chemical, fire hazard and safety hazard properties of the ingredients used in printing inks.

For information, contact the director, Professor John W. Vanderhoff, Sinclair Laboratory 7, Lehigh University, Bethlehem, Pa. 18015.

The Wetlands Institute

This facility is a joint activity between The Wetlands Institute, incorporated as a nonprofit organization, and Lehigh University. The university operates the institute under its Center for Marine and Environmental Studies.

The Wetlands Institute, which commenced operations in 1972, is located on a 34-acre site on the edge of a coastal salt marsh near Stone Harbor, N.J. It is a research and teaching field station. Following the practice of other seaside marine research stations, educators and researchers from other colleges and universities may use the facilities for research and education that falls within the general objectives of the institute.

These are to increase the understanding of the natural processes controlling the wetlands ecosystems through fundamental research; to investigate the renewability of the natural resources and to increase the biotic potential of the wetlands area; to ascertain the effects of disturbances caused by man's activities, and to find methods of minimizing these effects through practical and applied research; to provide factual scientific information that can serve others as a basis on which to make intelligent decisions for the long-range beneficial multiple use of

coastal areas; to train scientists and engineers in methods of solving and of preventing problems in the coastal zones; and to educate the general public, both resident and vacationing, in the importance of wetlands to the general ecology of coastal areas, to the need for preserving and for enhancing the wetlands in maintaining those aspects of the coastal zones that make them attractive to residents and vacationers, and what each person can do to protect the environment.

The Wetlands Institute provides facilities for year-round studies of the surrounding environment and includes six research laboratories, dormitory space and kitchen facilities, lecture room and demonstration area, flowing salt water system, maintenance shop, scientific laboratory equipment, and outboard motor skiffs.

Research activities. Current research interests include: salt marsh food webs; physiological criteria for determining sublethal effects of various environmental parameters; sedimentation studies; geochemistry of coastal salt marsh waters; beach sand studies; microbial mineralization of cellulose and chitin in salt marshes; new techniques for identification of planktonic fish eggs; viral diseases of fish; effect of sewage on marine organisms; and oil pollution studies.

Educational opportunities. Formal graduate studies are offered through the graduate programs in various departments of the university.

One facet of graduate student training is related to preparation of scientists to continue studies of the coastal area; the other is concerned with providing school science teachers with sufficient training so that they are able to return to the classroom and pass on vital information about the tidal wetlands to their students.

In conjunction with teacher training, every effort is made to provide lectures, demonstrations and tours of the wetlands for classes. Selected undergraduate courses also are offered as part of the summer program.

For information, write to the director, Professor Vincent G. Guida, Chandler-Ullmann Hall 17, Lehigh University, Bethlehem, Pa. 18015.

Research Organizations

In addition to the diverse research and educational entities of the university that are described in the preceding section, Lehigh has four other organizations that have special functions and that do not fit neatly into the other categories.

Office of Research

The Lehigh Institute of Research was organized in 1924 to encourage and promote scientific research and scholarly achievement in every division of learning represented in the university, and in recognition of the need for further and more exact knowledge in science and in the application of science to the affairs of modern life.

The institute was reorganized in 1945 in recognition of the increasing role of governmental agencies and industry in sponsoring research, and renamed in 1968 in recognition of its administrative function.

The Office of Research functions as an administrative service unit to the faculty and administration of the university and is involved in a variety of activities, which include the following: assisting the faculty in the submission of preliminary proposals, the preparation and budgeting of unsolicited proposals and responses to formal requests, proposal review, and managing the project award. Once an award is received, the Office of Research acts a liaison between the project director and the funding agency, as well as assuring institutional compliance with sponsors' policies, *e.g.*, fiscal, patent, property, human subjects, use of animals, etc.

The office is staffed by a director, an assistant, director, two research administrators, an administrative assistant, and has secretarial/clerical support.

Office of Research Program Development

The Office of Research Program Development provides support and assistance to faculty in identifying funding opportunities for research programs. Particular attention is paid to helping new faculty develop their research programs and obtain needed research equipment. The office administers the fund for unsponsored research whereby faculty can obtain modest support at a crucial, early stage in their research before significant external support is feasible. The office serves from time to time as a focal point in developing large-scale research projects that span several disciplines. Faculty awareness of potential sponsors is encouraged by maintaining close coordination with the faculty, deans, department chairpersons, research directors and the Office of Research. The office provides a convenient point of contact for industrial firms interested in obtaining faculty assistance on a broad range of research topics. The office further publicizes the effort of Lehigh researchers and the results of research programs across campus.

Structural Stability Research Council

The Structural Stability Research Council (formerly Column Research Council) was founded in 1944 by the Engineering Foundation to review and resolve the conflicting opinions and practices that existed at that time with respect to solutions to stability problems, and to facilitate and promote economical and safe design. The Council has been headquartered at Fritz Engineering Laboratory since 1966.

At the core of the council's activities are eighteen task groups and nine task reporters. At its annual technical session, a forum is provided whereby the latest research results pertaining to these groups are presented. This represents a primary source of the highlights of the latest solutions to structural problems before they are eventually published in technical journals.

The council offers guidance to specification writers and practicing engineers by developing both simplified and refined calculation procedures for the solution of stability problems, and assessing the limitations of these procedures. The council's major publication is the *Guide to Stability Design Criteria for Metal Structures*. Now in its third edition, this book is the most comprehensive treatment available anywhere in the world on stability problems associated with metal structures.

The international membership of the council is made up of representatives from governmental and private organizations concerned with specifications and design procedures for metal structures, representatives of consulting firms engaged in engineering practice, members-at-large selected from universities and design offices, and corresponding members from various countries who are in touch with stability research in their region.

Many former Lehigh University graduate students and research workers are now active members of the council. A number of Fritz Engineering Laboratory research projects have received the guidance of the council's advisory committees.

For more detailed information, contact Dr. Lynn S. Beedle, SSRC Director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa. 18015.

Council on Tall Buildings and Urban Habitat

The Council on Tall Buildings and Urban Habitat, and international activity sponsored by engineering, architectural, and planning professionals, was established in 1969 to study and report on all aspects of the planning, design, construction, and operation of tall buildings.

The council's five professional society sponsors are: International Association for Bridge and Structural Engineering, American Society of Civil Engineers, American Institute of Architects, American Planning Association, and the International Union of Architects. In 1974 the council was admitted as a consulting nongovernmental organization to United Nations Educational, Scientific and Cultural Organization under

Category C. In 1979 it was upgraded in its interactions with UNESCO to Category B.

The council is concerned with the impact of tall buildings on the urban environment and in the role they play in urban life. This involves a systematic study of the problem of providing adequate space for life and work, considering not only technological factors, but social and cultural aspects as well. Important activities include the identification and stimulation of needed research and implementation of findings into codes, specifications, and standards.

The five groups that carry out the major activities of the council are Planning and Environmental Criteria for Tall Buildings (PC); Tall Building Systems and Concepts (SC); Tall Building Criteria and Loading (CL); Structural Design of Tall Steel Buildings (SB); and Structural Design of Tall Concrete and Masonry Buildings (CB).

A major focus of the council is a comprehensive five-volume monograph on the planning and design of tall buildings. The five volumes correspond to the five topical groups listed above. They cover environmental aspects, transportation and other planning aspects; service systems, structural systems; the various loading systems; structural safety, foundations, and structural design methods and limit states—the latter covering both steel and concrete buildings.

The monograph is kept current through a series of monograph update volumes that are released at appropriate intervals. In addition, individual chapters will be revised and separate volumes released as more information becomes available. The council is not an advocate for tall buildings, *per se*, but in those situations in which such buildings are viable, it seeks to encourage the use of the latest knowledge in their implementation.

The headquarters of the council is at Lehigh University. Nearly 1,200 specialists, primarily engineers, architects, planners, and sociologists from seventy countries, are involved in the work of its committees. A number of these committees provide advisory guidance for relevant Lehigh research projects.

For more detailed information, contact Professor Lynn S. Beedle, director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa. 18015.

Academic Centers

The university has three centers in the College of Business and Economics where specialized work is performed. These are the Center for Economic Education, the Fairchild-Martindale Center for the Study of Private Enterprise, and the Small Business Center.

Center for Economic Education

The Center for Economic Education was established in 1976. It is part of a nationwide network of more than 150 such centers under the guidance of the Joint Council for Economic Education.

For more than a quarter of a century, the Joint Council has been involved in programs to reduce the level of economic illiteracy in the United States. The purpose of Lehigh's center is to increase the quantity and improve the quality of economic education.

Located in Drown Hall, the center is part of the College of Business and Economics. But it takes on an interdepartmental role as it coordinates programs aimed at heightening understanding of the American business and economic system. The center serves as a clearing house for educational ideas. It also houses an expanding resource library including books, films, filmstrips, curriculum material, testing packets, and simulation games for use by faculty and area educators.

Research activities. The major goal of the center is not primary research. Still, the center is undertaking need assessment studies to establish priorities for economic education programs. The center is involved in projects to determine effective teaching strategies and testing procedures. In addition to this, the center serves to direct programs which involve faculty in projects designed to explore areas of concern such as energy economics, law and economics, capital formation, etc.

Educational opportunities. An integral part of the center's operation is a summer institute for teachers. The institute is designed to give teachers from all levels the basics of economics as well as assistance in incorporating these concepts into the classroom. The summer institute features courses taught by faculty members and individualized workshop sessions with education specialists. Participants receive college credit for the institute and may enroll in an ongoing summer program leading to the M.A. in economics.

Each semester one or two undergraduates work with the center director on projects ranging from research into the teaching of economics to compilation of information for the publication of a newsletter. Other students are involved in the development of campus-wide economics programs.

The center also sponsors workshops, seminars and guest lectures designed to meet the educational needs of faculty and students. Sessions such as the American Iron and Steel Industry Economic Seminar allow members of the Lehigh community to meet with academic and business leaders to discuss economic issues relating to the industrial process.

For further information, write to the center's director, William T. Alpert, Center for Economic Education, Drown Hall 35, Lehigh University, Bethlehem, Pa. 18015.

Fairchild-Martindale Center for the Study of Private Enterprise

The Fairchild-Martindale Center for the Study of Private Enterprise was established in 1980 by a gift from Harry and Elizabeth Martindale. The primary purpose of the center is to contribute through scholarship to the advancement of public understanding of the structure and performance of our economic system.

Attention is focused on the private sector of the economy and on public policies as they influence the private sector. To achieve this end, the center activities include the sponsorship of lectures and conferences, support of faculty research, the issuance of occasional center publications, and a center associates program for a select group of undergraduate students in business and economics.

For further information, write to the center's director, Professor J. Richard Aronson, Fairchild-Martindale Center for the Study of Private Enterprise, Drown Hall 35, Lehigh University, Bethlehem, Pa. 18015.

Small Business Center

The Small Business Center was established in 1977 for the benefit of students, faculty, and owners of small businesses in the Lehigh Valley. The function of the center is to bring together in one location the skills and expertise of faculty and students with the information and resources of the various levels of government in one location for easy access by the small business community.

The center involves students in a practical learning experience as counselors to business and planners of new ventures. Counseling is provided through LUMAC (Lehigh University Management Assistance Counseling), a three-credit graded course offered each semester. Approximately fifty businesses are served each year through the efforts of ninety students each semester. The center also provides services through the Lehigh Valley chapter of SCORE (Service Corps of Retired Executives).

The center conducts studies regarding problems faced by small business and the impact of the general economy on the problems of the formation and operation of small business. The center also studies characteristics of entrepreneurs.

For further information, write to the center's director, Professor John W. Bonge, Small Business Center, 412 S. New St., Bethlehem, Pa. 18015.

V

Descriptions of Undergraduate and Graduate Courses

This section includes listings of undergraduate and graduate courses offered by Lehigh University. For purposes of record, all approved courses are listed. It must be understood, however, that the offerings in any given semester are contingent upon a number of factors, including student needs as determined at the time of preregistration.

Credit Hours

The number in parentheses following each course title indicates the credit value of the course in terms of semester hours ("credit hours"). Three hours of drawing, of work in the laboratory, or of practice in the field are regarded as the equivalent of a recitation or lecture of one hour's duration.

Course Numbering

The course numbering system specifies which courses can be applied to the program of study as the student progresses toward the undergraduate or graduate degree. In general, the numbering series is as follows:

0-99. Undergraduate courses, primarily for underclassmen. Not available for graduate credit.

100-199. Undergraduate courses open to freshmen on petition. Not available for graduate credit.

200-299. Courses open to advanced undergraduates and graduate students. Not available for graduate credit in the major field.

300-399. Courses open to advanced undergraduates and graduate students. Available for graduate credit in the major field.

400-499. Courses open to graduate students only, and undergraduates by petition.

Provisional Courses

Each instructional department is authorized to offer provisional courses, or those offered on a trial basis, as well as special opportunities courses. Such courses can become a permanent part of the university curriculum. These courses are numbered, as is appropriate, . . 97-98, . . 197-198, . . . 297-298, . . . 397-398, for a maximum of two semesters.

Students may take 97-98 series courses pass/fail under the standard procedures for pass/fail.

Apprentice Teaching

The apprentice teaching program is designed to benefit students with junior or senior standing who want to learn about teaching under the guidance and supervision of an experienced teacher. The apprentice receives instruction and experience in many aspects of the teaching process while working with the master teacher in a course taught by the master teacher.

Master and apprentice teachers are responsible for submitting to the departmental chairperson an outline of the activities in which the apprentice will participate. The outline must be approved and kept on file. Apprentices typically receive three hours of credit for regularly attending classes, doing a limited amount of observed lecturing or leading of discussions, assisting in making up and evaluating some written assignments, and being available for individual consultation with students.

Apprentice teachers should have an over-all cumulative grade-point average of 2.8 or better or a cumulative grade-point average of 3.2 in the major field in which the apprentice teaching is done, and should previously have taken for credit the course in which they will apprentice, or its equivalent. A student may register for apprentice teaching only once each semester, and only twice during the college career, for a total of not more than six hours of credit. The student may register to be an apprentice teacher in a given course only once.

A graduate student who is not a paid teaching assistant

may register for apprentice teaching, but the department decides whether the student may receive credit that will count toward fulfilling requirements for a graduate degree. The apprentice is graded for work in the course by the master teacher.

Students who wish to do apprentice teaching in extradepartmental courses, such as those offered as Freshman Seminars, may do so with the approval of the director of the program. In provisional courses (those offered on a trial basis) or courses cross-listed in several departments, the approval of the chairperson of the department that offers the course is required. In such cases, the student registers for the 300-level course with the same headings as the course in which he or she is an apprentice (e.g. FS 300, Apprentice Teaching in FS 97C).

This program carries the following provisions: except with the college dean's approval, professors do not accept more than two apprentice teachers per semester; master teachers supervise all aspects of the apprentice's work; the duties of the apprentice teacher are restricted to those that will provide a learning experience for the apprentice without inhibiting the educational experience of students taking the course; the duties of apprentice teachers are not to be confused with those performed by paid graduate teaching assistants; and the master teacher provides a report on the apprentice teaching experience to the departmental chairperson and to the dean of the college.

Prerequisites

Academic preparation required for admission to courses is indicated under "prerequisites" included at the end of each course description. Prerequisites are stated in most cases for purposes of convenience in terms of Lehigh courses. Academic status required for admission, where numbering does not fully describe this status, is also indicated under "prerequisites."

A student who does not have the status (e.g., sophomore standing) or the academic preparation set forth as prerequisites must, in order to be admitted to a course, file with the registrar at the time of registration and on a standard form provided, a waiver of prerequisites signed by the chairperson or head of the teaching department or division, and the student's curriculum director. Academic work completed elsewhere must be attested in this manner as being substantially equivalent to prerequisites listed, unless the student's records in the office of the registrar show that the proper officers have so evaluated this preparation previously.

Engl 2, 3, 6, 8 and 10 are prerequisites to all 100- or higher-level courses. Exceptions may be made only by petition to the committee on standing of students.

In a few cases, corequisites are indicated. In such instances the corequisite course is taken in the same semester.

Abbreviations

Whenever possible, course listings contain information indicating what requirements the course satisfies, the semester or semesters in which it is offered, and the name of the scheduled instructor or instructors.

While all information herein is subject to change, the information is included to serve as a guide in the selection of appropriate courses that best fulfill the student's academic requirements and personal goals.

The symbols following course titles for some College of Arts and Science courses include:

NS. Psychology department courses that meet the Natural Science distribution requirements.

SS. Psychology department courses that meet the Social Science distribution requirements.

Status of Divisions

A number of areas of study are listed independently of the parent department's entry. For example, Astronomy, taught in the mathematics department, is listed under Astronomy. Similarly, courses offered by divisions of departments are listed alphabetically rather than with the departmental entry. Among such courses are journalism (a division of the English department), speech and theater (another division of the English department), and computing and information science (a division of the mathematics department). A number of language courses are listed under the entry for the department of modern foreign languages, rather than alphabetically.

Computers Versus Computing

The reader may want to note the differentiation between certain like-sounding programs of study. Students desiring to learn how to design computers study in the department of electrical and computer engineering. Those who want to learn how to handle data via computers study in the division of computing and information science, department of mathematics.

Faculty Identification

In many cases, the names of professors scheduled to teach a course are listed at the conclusion of the course description entry. In most instances, those identified in this way are listed as faculty members in the introductory section to each department. In a few cases, however, the teacher may be associated with another department. In any case, identification of the individual and his or her credentials may be found in the alphabetical listing of faculty members in Section VII.

Information Limits

The course descriptions are intended to guide the student in selecting appropriate courses. For reasons of space, descriptions are brief. In most cases, courses will have a significantly broader scope than the topics listed in the description. In some courses, material may change from what is described. If there is doubt concerning the appropriateness of any course for the individual's educational objectives, it is suggested that the student confer with the adviser.

A Choice of Titles

Note: Principal officers of academic departments are identified as *chairpersons* in most cases. Individuals who prefer to be known as *chairman* are identified accordingly. The responsibilities are identical regardless of which term is used.

Accounting and Law

Professors. Brian G. Brockway, LL.B., LL.M., Distinguished Professor of Law; James A. Largay, III, Ph.D., C.P.A., Arthur Andersen & Co. Alumni Professor of Accounting; Frank S. Luh, Ph.D.; Robert H. Mills, Ph.D., C.P.A.; Carl L. Moore, M.A., C.P.A.; James B. Hobbs, D.B.A.
Associate professors. Kenneth P. Sinclair, Ph.D.; Stuart K. Webster, Ph.D., C.P.A., *chairman.*
Assistant professors. D. Raymond Bainbridge, Ph.D., C.P.A.; Malcolm Barksdale, J.D.; Ralph E. Drtina, Ph.D., C.P.A.; Marilyn K. Gerdes, J.D.; James A. Hall, Ph.D.; John W. Paul, Ph.D., C.P.A.; Lamont F. Steedle, Ph.D., C.M.A.; James W. Tobak, M.A., J.D.
Adjunct professor. Harry A. Dower, J.D.

The department of accounting and law offers a wide variety of courses in accounting and business law which: support the College of Business and Economics core requirements; provide an undergraduate major in accounting; are elective courses for other College of Business and Economics undergraduate majors; support the Law and Legal Institutions minor program; and form a key component of the master of business administration program. The upper-level undergraduate courses have a professional accounting orientation which continues to sustain a large enrollment in the accounting major. Within the major, there is the opportunity to choose electives that emphasize the various career opportunities

within the broad field of accounting: financial, managerial, taxation, auditing, and information systems.

Many students prepare for the various professional examinations during their collegiate careers. Primary among these is the C.P.A. examination followed by the growing C.M.A. (certificate in management accounting) program. A C.P.A. Review Course (without credit) is available to seniors on a voluntary basis in the spring semester.

Note: Students interested in satisfying the requirements to take either the C.P.A. (certified public accountant) or C.M.A. (certificate in management accounting) examination should consult the chairperson of the department or their major adviser. With proper planning, it is possible to satisfy the most stringent course selection criteria, i.e., current New York State requirements.

The specialized accounting courses at the 300 level are frequently offered in graduate sections in addition to the 400-level courses. These graduate offerings permit M.B.A. students to take a limited concentration of nine to twelve credit hours in accounting. If they have taken twelve to fifteen credit hours in accounting as undergraduates, their total professional preparation of 21 to 27 hours represents a sound basis for a career in public, industrial or governmental accounting.

The Accounting Major

The program is offered in the College of Business and Economics. Required: 15 credit hours beyond core requirements.

Acctg 315	Financial Accounting I (3)
Acctg 316	Financial Accounting II (3)
	accounting electives (except Acctg 390) (9)

Undergraduate Courses in Accounting

51. Essentials of Accounting I (3) fall-spring
The organization, measurement and interpretation of economic information. Introduction to accounting theory, concepts and principles, the accounting cycle, information processing, and finanical statements. Exposure to controversial issues concerning income determination and valuation. Prerequisite: sophomore standing.

52. Essentials of Accounting II (3) fall-spring
Financial statement analysis for managerial and external use. The use of economic information for managerial planning and control. Introduction to job order, process, and standard cost accounting, variable costing and volume-mix-price-cost relationships. Prerequisite: Acctg 51.

108. Fundamentals of Accounting (3) fall-spring
A one-semester survey of accounting principles and practices, including an introduction to industrial cost systems designed for those students planning to take only one accounting course. Other students should take the Acctg 51-52 sequence.

111. Computers in Business (3) fall-spring
An introduction to computers with emphasis on business applications. Students develop a working knowledge of a computer language sufficient to solve business problems. Basic knowledge of hardware, software, error control, integrated systems, and simulation. Not open to students who have had a previous equivalent course (normally three credit hours) in computers.

For Advanced Undergraduates and Graduate Students

300. Apprentice Teaching in Accounting (1-3)

307. Federal Tax Accounting (3) fall-spring
An introductory exposure to the federal income tax laws, rules, and regulations applicable to income tax determination of individuals, partnerships, and corporations. Tax planning and timing of transactions is emphasized. Prerequisites: Acctg 51 and 52. Brockway and Largay

309. Federal Taxation of Business Associations (3)
The theory, policy and law pertaining to federal taxes involving partnerships, corporations, estates and trusts. Problem solving, research, and planning are emphasized. Prerequisite: Acctg 307. Brockway

311. Accounting Information Systems (3) fall
A general introduction to the development and implementation of an electronic data processing accounting information system. The course considers the tools and techniques used by someone performing the systems function. Prerequisites: Acctg 52 and Acctg 111. Hall

315. Financial Accounting I (3) fall
Intensive study of the basic assumptions and principles of accounting, the accounting process, and problems concerned with presenting fairly the financial position and operating results of business entities. Consideration of the measurement of current assets, current liabilities, noncurrent assets, long-term debt, and preparation of financial statements. Prerequisites: Acctg 51 and 52.

316. Financial Accounting II (3) fall-spring
A study of generally accepted accounting principles and problems concerned with presenting fairly the operating results, financial position, and changes in financial position of business entities. Consideration of shareholders; equity, earnings per share, tax allocation, pensions, leases, and price level changes. Preparation, analysis, and interpretation of financial statements. Prerequisites: Acctg 51 and 52. Bainbridge and Webster

317. Advanced Accounting (3) spring
Problems of business combinations and consolidations, partnerships and accounting as it applies to not-for-profit entities, foreign exchange, and fiduciary accounts. Prerequisite: Acctg 315 or 316. Largay and Luh

320. Auditing (3) fall
Survey of auditing theory, objectives, and practices relating largely to the responsibilities of independent professional accountants; ethics of the profession, generally accepted auditing standards, internal control, examination of various systems including electronic data processing, statistical methods, report writing, etc. Prerequisite: Acctg 315. Paul

324. Cost Accounting (3) spring
Principles and practices of industrial cost accounting, including cost planning and budgeting, cost controls, job lot and standard and process systems, variance analysis, performance reports, costs in management decisions. Prerequisite: Acctg 52.

371. Directed Readings (1-3)
Readings and research in various fields of accounting; designed for superior students who have a special interest in some topic or topics not covered by the regularly rostered courses. Written term paper(s) required. Prerequisite: preparation acceptable to the department chairperson.

372. Special Topics (1-3)
Special problems and issues in accounting for which no

regularly scheduled course work exists. When offered as group study, coverage varies according to interests of the instructor and students. Prerequisite: preparation in accounting acceptable to the department chairperson.

390. Internship (3-6)
Designed to give advanced students of accounting, who have maintained a satisfactory standard of scholarship and who show promise in the field of accounting, an opportunity to acquire field experience and training with selected industrial or public accounting firms or governmental agencies as a complement to the academic learning process. Outside readings are assigned. Written reports are submitted by students and a performance evaluation is made by the employer. The amount of credit is influenced by the length of the training period and the character of the experience afforded to the trainee, but does not exceed six credit hours for a regular semester or three credit hours for a summer period of at least eight weeks. Prerequisite: junior standing and approval of the faculty committee on internship.

Accounting and Law for Graduate Students

Undergraduates may wish to plan a program that includes the M.B.A. degree as part of the professional accounting preparation. For information about C.P.A. requirements in different states, the C.M.A. certificate, or for the selection of accounting electives, consult the department chairperson.

403. Financial Flows and Accounting Measurements (3)
Corporate financial reporting: identification, accumulation and communication of financial information to management and other users. Generally accepted accounting principles, uses and limitations of accounting information, asset valuation, income determination, funds flow, and analysis and interpretation of financial statements.

404. Commercial Transactions and Business Organizations (3)
The study of the law of contracts, especially as it applies to the sale of goods; and the study of the law of agency, partnerships, and corporations. Prerequisite: Acct 403.

408. (IE 408) Management Information Systems (3)
Integrated and total systems concepts for organizational data bases and information systems as applied to planning, development, and implementation of computer-based management information systems. Emphasis placed on the interaction of information systems with management planning and control. Prerequisite: an advanced course in information systems and a knowledge of programming.

413. Managerial Accounting and Decision-Making (3) every semester
Cost accounting techniques for management planning and control. Responsibility accounting, budgeting, cost behavior, cost estimating and allocation, product costing, relevant costs, cost variance analysis, information requirements for decision models, divisional reporting, and performance evaluation. Prerequisite: Acct 403 or equivalent.

421. Information Systems for Managers (3)
Information processing, computer, and data structure concepts in producing information. Communications between user management and data processing management in the systems development process. Control of systems development activities, data based systems, and distributive processing systems. Projects and case studies. Hall

431. Accounting Theory and Thought (3)
Critical and historical examination of modern accounting concepts. Measurement, communication, and interpretation of enterprise income, capital, and related economic data. Prerequisite: 15 credit hours of accounting. Largay

432. Legal Problems in Business (3) every semester
Specific legal problems involved in making business decisions. Emphasis is placed on preventive law and the tax consequences of business transactions. Prerequisites: a course in law and corporation finance. Dower

433. (IE 408) Management Information Systems (3)
Integrated and total systems concepts for organizational data bases and information systems as applied to planning, development and implementation of computer-based management information systems. Emphasis placed on the interaction of information systems with management planning and control. Prerequisite: an advanced course in information systems and a knowledge of programming.

435. Advanced Management Accounting (3) spring
Managerial planning and control problems with emphasis on the responsibilities of the accountant. Practical applications using cases. Includes advanced treatment of management control systems, managed costs, transfer pricing, and the capital investment problem. Prerequisite: Acct 413 or a course in cost accounting.

437. Federal Taxation and Business Decisions (3)
Impact of federal taxation on the structure and timing of business decisions. Problem-solving methods and research techniques from a managerial perspective. Not available to students with two or more courses in taxation. Prerequisite: A basic course in accounting. Brockway

439. Contemporary Issues in Financial Reporting (3)
Corporate financial reports from the perspective of the user-analyst: disclosure, price level accounting, foreign currency, business combinations, leases, and analysis of financial statements. Case studies. Prerequisite: Acct 413.

471. Directed Readings (1-3)
An extended study of an approved topic in the fields of accounting and law. May be repeated.

472. Special Topics (1-3)
Special problems and issues in accounting and law for which no regularly scheduled coursework exists. When offered as group study, coverage varies according to interests of the instructor and students. Prerequisite: preparation in accounting and law acceptable to the department chairman. May be repeated.

Undergraduate Courses in Law

11. Introduction to Law (3)
A study of the nature and function of law and the legal system, the study of legal reasoning through the use of the case method. Required first course in the Law and Legal Institutions minor program. Open only to freshmen and sophomores except with the consent of the coordinator of the program.

201. Business Law (3) every semester
The law of contracts, agency, sales under the uniform commercial code and business organizations. A case and problems approach issued to develop analytic methods and research skills involved in the examination of numerous types of commercial transactions. Prerequisites: Eco 1, Acctg 51 or Acctg 108.

202. Business Law (3) spring
The law of negotiable instruments, secured transactions, real and personal property, corporations and

partnerships. A case and problem approach is used. Prerequisites: Law 201 and Fin 225.

221. (Phil 221) Sex-Discrimination and the Law (3)
A critical study of the law of sex discrimination in areas of constitutional and labor law. A case approach that places emphasis on the rights of employees and the obligations of employers. Topics include equal protection, equal employment opportunity, and affirmative action. Lindgren

300. Apprentice Teaching in Law (1-3)

371. Directed Readings (1-3)
Readings in various fields of law, designed for students who have a special interest in a field of law.

Administration and Supervision

Course listings for this department in the School of Education may be found on page 123.

Aerospace Studies

Professor. Col. Charles B. Simons, M.S., *chairperson.*
Associate professor. Lt. Col. John G. Christenson, M.A.
Assistant professors. Capt. Freddie G. Auschwitz, M.S.; Capt. Thomas L. Brown, M.P.A.; Maj. Ronald Stankiewicz, M.B.A.
Adjunct professor. Col. Lawrence Hasbrouck, M.B.A.

The Air Force Reserve Officers Training Corps (AFROTC) program at Lehigh was established in 1946. The program is conducted through the department of aerospace studies, which offers two voluntary programs, one of four years and one of two years, for students to qualify for a commission as a second lieutenant in the Air Force.

The general objective of the Air Force program is to instill in each student a basic understanding of associated professional knowledge, a strong sense of personal integrity and individual responsibility, an appreciation of the requirements of national security, and an opportunity to learn and develop leadership ability. The academic courses are available to all Lehigh students whether or not they want a commission.

Course credit. Advanced aerospace studies course credit may be substituted for six hours of electives for students in the College of Arts and Science and in the College of Business and Economics. In the College of Engineering and Physical Sciences, six credit hours are awarded in the normal program for a degree, but not within the "minimum" program.

Minor in Aerospace Studies

This program is designed to prepare an individual for commissioning as a second lieutenant in the U.S. Air Force and service as an Air Force officer upon graduation. It is a required program for any Lehigh student who plans to receive a commission in the Air Force through AFROTC. The minor recognizes two basic needs of Air Force officers: familiarization with mathematical concepts, and the officer as a manager and leader who can effectively communicate with others.

The minor in aerospace studies includes the following courses:

AS 11, 12	Freshman Aerospace Studies (2)
AS 13, 14	Sophomore Aerospace Studies (2)
AS 101	Field Training (0)
AS 113, 14	Air Force Management and Leadership (6)
AS 103	Flight Instruction (0)
AS 115, 116	National Security Force in Contemporary American Society (6)
Engl 1, 2	Composition and Literature (6)
Math 21	Analytic Geometry and Calculus (4) or (3)
	total credit hours 26 (25)

Notes: AS 103 is mandatory for, and available only to pilot candidates not already possessing a Federal Aviation Administration private pilot's license during their last two years of aerospace studies.

Engl 10, 14 or 16 may replace Engl 2

Math 31 (4 credit hours), Math 41 (3), or Math 388 (3) may replace Math 21. Other mathematical reasoning courses may be substituted with the approval of the department chairperson.

A maximum of six credits in aerospace studies courses may be included in the credits required for graduation.

Advanced credit granted by Lehigh for any of the required courses listed above will be credited toward the minor. A minimum grade of C must be earned in each course for the student to be eligible for designation as a distinguished graduate. The department of aerospace studies monitors the minor.

Four-Year Program

The four-year program consists of classroom and laboratory work during the four undergraduate years and four weeks of field training, usually between the sophomore and junior years, at an airbase.

During the first two years, the program acquaints students with aerospace history, the mission and organization of the Air Force, including technological advances and current research and development activities. Students also begin leadership training. During the last two years, emphasis is placed on personal development. Students practice leadership talents and abilities by assuming positions of responsibility in the Cadet Corps.

Two-Year Program

All requirements for commissioning can be completed in the two-year program. Students may apply for entry if they intend to complete two more full academic years either undergraduate, graduate, or a combination of both. Prior to formal enrollment, each student successfully completes six weeks of field training at an Air Force base.

General Information

Air Force ROTC awards scholarships at the freshman, sophomore and junior levels. They are available to qualified cadets in the two-year and four-year programs. Scholarships are given on a semester basis. The maximum is eight semesters (four years), the minimum four semesters (two years). Scholarships of seven, six and five semesters are also available.

Aerospace Studies Courses

11. The Air Force Today (1) fall
A study of the doctrine, mission and organization of the U.S. Air Force. A study of tactical and airlift forces, their mission, function, and employment.

12. The Air Force Today (1) spring
A study of U.S. strategic offensive and defensive forces, aerospace support forces, and a review of Army, Navy and Marines general-purpose forces.

13. The Development of Air Power (1) fall
An examination of the developmental growth of air power from Revolutionary War days to the conclusion of World War II by reviewing the various concepts of employment and focusing upon the factors which prompted research and technological change.

14. The Development of Air Power (1) spring
A continuation of AS 21 from the conclusion of World War II to the present, with emphasis on a variety of events and elements in the history of air power, especially where these provide significant examples of the impact of air power on strategic thought.

101. Field Training (0) summer
In order to receive a commission through Air Force ROTC, a student attends field training, normally during the summer following the sophomore year. Sessions include career and job orientation, organization and function of an Air Force base, junior officer training, physical training, small arms marksmanship, and survival. Travel pay is provided. Students receive approximately $100 per week in addition to room and board.

102. Advanced Training Program (0) summer
An honors program, highly recommended but not required to receive a commission. ATP is a two- or three-week orientation program on an Air Force installation, normally taken the summer prior to the final year by those with high academic standing. The program provides specialized career orientation and an opportunity to observe a working Air Force facility. The program provides contact with officers working in the student's speciality. Transportation, lodging and meals are provided in addition to approximately $100 per week.

103. Flight Instruction Program (FIP) (0) fall-spring
An introduction to powered flight taken during the last two years in AFROTC for those students who are scheduled to enter Air Force pilot training after commissioning. Includes approximately fourteen hours of ground school covering principles of flight, flying and radio procedures, weather and navigation. Thirteen hours of student flying include twelve hours dual and one solo. Successful completion requires passing an FAA flight evaluation. Prerequisites: AS 113, 114, acceptance into the Air Force ROTC program as a pilot candidate, and consent of the chairperson. Not open to those who hold an FAA private pilot's license.

113. Air Force Management and Leadership (3) fall
AS 113 and 114 are integrated management courses, emphasizing the individual as a manager in an Air Force milieu. The individual motivational and behavioral process, leadership, communication, and group dynamics are covered to provide a foundation for the development of the junior officer's professional skills. Organizational and personal values, management of forces in change, organizational power, politics, and managerial strategy and tactics are discussed. Actual Air Force cases are used.

114. Air Force Management and Leadership (3) spring
A continuation of AS 113.

Airborne Training Program (0) summer
Appropriate classroom, physical conditioning, and airborne parachute training (including five controlled parachute jumps) are available through a cooperative Air Force-Army program similar to that offered Air Force Academy cadets. Aerospace studies students volunteering for this course spend the summer preceding their final year in AFROTC. This is not required training. Prerequisite: As 101.

115. National Security Forces in Contemporary American Society (3) fall
AS 115 and 116 conceptually focus on the armed forces as an integral element of society, with an emphasis on the broad range of American civil-military relations and the environmental context in which U.S. defense policy is formulated and implemented. In each semester, students prepare individual and group presentations for the class, write reports, and participate in group discussions, seminars and conferences.

116. National Security Forces in Contemporary American Society (3) spring
A continuation of AS 115.

American Studies

American Studies Committee. William G. Shade, Ph.D., professor of history and *director of American Studies;* James R. Frakes, Ph.D., Edmund W. Fairchild Professor of American Studies; Joseph A. Dowling, Ph.D., distinguished professor of history; Peter G. Beidler, Ph.D., Lucy G. Moses Distinguished Professor of English; Lawrence H. Leder, Ph.D., professor of history; Edward J. Gallagher, Ph.D., associate professor of English; James R. McIntosh, Ph.D., associate professor of social relations; Howard R. Whitcomb, Ph.D., associate professor of government; Nicholas Adams, Ph.D., assistant professor of art and architecture; Alice L. Eckardt, M.A., assistant professor of religion studies, and David Curtis Amidon, Jr., M.A., lecturer in urban studies.

American Studies is an interdepartmental major emphasizing the idea that the institutions and values of a society comprise a whole, not merely the sum of its parts. By concentrating on the unique expressions of individuals contained in both the arts and popular culture and by studying the historical movements and contemporary institutions within which these expressions develop, American Studies reveals relationships that may not be clearly seen within the framework of a single discipline.

The broad interdisciplinary nature of American Studies equips the student with a well-rounded general education and a wide range of career opportunities. The student may choose to emphasize American history or literature to provide an excellent preparation for graduate school in these areas as well as in American Studies. In addition the major can be combined with other majors, such as journalism, or minors, such as business or Law and Legal Institutions, to furnish a sound underpinning for careers in those areas. With suitable collateral courses, the major also can prepare students for advanced work in museum administration, library science, social work and for teaching in both secondary schools and community colleges.

The major consists of fifteen credit hours of preliminary courses dealing with American literature, history, and popular culture. All students in any major program are also required to take two American Studies courses, one at the intermediate level introducing the general approach of the major and a senior seminar on contemporary American civilization. In connection with the director of American Studies, who serves as the adviser for the major, each student chooses a program of fifteen semester hours of upper-level courses drawn from four different groups. The major requirements total 36 credit hours.

required preliminary courses (15 credit hours)

Hist 9	Formation of American Society (3)
Hist 10	American Society in the Industrial Era (3)
Engl 23	American Literature I (3)
Engl 24	American Literature II (3)

Choose three hours in the area of American Popular Culture from the following:

Soc 53/55/57	Popular Culture (1-3)
Engl 63	Narrative Film (3)
Engl 89	Science Fiction (3)
Engl 189	Popular Literature (1-3)

required American Studies courses (6)
Intermediate level: Arts 111, The American Character (3)

Upper-level seminar: Arts 311, Themes in Contemporary American Civilization (3)

required upper-level courses (15)
Choose at least six hours each from two groups.

Literature

Engl 376	Early American Literature (3)
Engl 377	American Romanticism (3)
Engl 378	American Realism (3)
Engl 379	Twentieth-Century American Literature (3)
Engl 380	Contemporary American Literature (3)
Engl 382	Themes in American Literature (3)

History

Religion Studies 53	Religion and the American Experience (3)
Hist 119	Colonial America (3)
Hist 120	Revolutionary America (3)
Hist 325	American Social History 1607-1877 (3)
Hist 326	American Social History Since 1877 (3)
Hist 327	American Intellectual History (3)
Hist 328	American Intellectual History (3)

Government and Society

Govt 317	American Presidency (3)
Govt 327	Socialization and the Political System (3)
Govt 351	Constitutional Law (3)
Govt 352	Civil Rights (3)
Urban Studies 321	White Protestant America (3)
Soc 141	Social Deviance (3)
Soc 364	The Family (3)
Soc 370	Juvenile Delinquency (3)

Minorities in America

Urban Studies 125	American Ethnic Groups (3)
Urban Studies 328	American Jewish Community (3)
Engl 311	Literature of Women (3)
Engl 312	Jewish Literature (3)
Engl 316	Indian in American Literature (3)
Engl 319	Black in American Literature (3)
Hist 131	Black Experience in America (3)
Hist 124	Women in American History (3)
Anthropology 182	Aboriginal Cultures of North American (3)

The courses listed here are recommended, but comparable courses in each of these areas may be substituted with written permission of the director of American Studies.

Admission to honors in American Studies is by invitation of the committee in the student's junior year. The student must attain an average of 3.2 in major courses in addition to the university honors requirements.

Anthropology

See listings under Social Relations.

Art and Architecture

Professors. Carlos J. Alvaré, M. Arch, M.C.P.; Richard J. Redd, M.F.A.
Associate professor. Ricardo Viera, M.F.A., director, Lehigh University Art Galleries
Assistant professors. Nicholas Adams, Ph.D., *chairman;* Paul D. Felder, M.Sc.; Lucy Gans, M.F.A.
Adjunct lecturer. Laurence S. Barkan, B.A.

The department of art and architecture offers three major programs: A *major in studio art* introduces the student to the basic media of art such as drawing, sculpture, printmaking, painting, and photography. For those interested in becoming a creative artist, intensive study at Lehigh as well as the other Lehigh Valley colleges is recommended; such a student can expect to take more than the required number of credits for the major.

A major in art can also be combined with psychology for those who seek a career in art therapy. It may also be combined with theater for those interested in costume design or with architecture and theater for those interested in set design. A major in art and minor in education is available for students interested in becoming public school art teachers.

The resources of the Lehigh University art collection are made available to many students taking classes in art studio. Prints, photographs, and paintings are often brought into the classroom and visits to art exhibitions on campus and elsewhere in the Lehigh Valley are a common part of art instruction.

Through the facilities of the Lehigh University art collection and its programs of art exhibitions, it is possible to see first-rate works of art on a regular basis. The annual contemporary art show is a special event. Several major museums are within easy traveling distance and the department runs monthly bus trips to New York City. An annual lecture series has brought architects and artists to campus. In recent years Anthony Machado and Charles Gwathmey, Peter Berg, and Lou Stoumen have appeared at Lehigh. Cooperation with Moravian College allows students to register for art courses not offered at Lehigh, such as ceramics.

The *architecture major* is a multidisciplinary major based in the department that draws on the resources of all Lehigh's colleges. Although architectural design is the primary concern of this major (beginning students should take Arch 3 or 4 and Arch 43), courses in architectural history, history, social sciences and engineering are recommended.

The architecture major leads to the liberal arts B.A. (bachelor of arts), a four-year degree. This degree is satisfactory for admission to graduate study in architecture and candidacy for the M.Arch. professional degree or for planning, preservation, or history of architecture.

In recent years students have gone on to graduate study in architecture at Yale, Penn, Columbia, Washington University, the University of Virginia and UCLA or to entry-level employment in the profession.

The junior year may be spent in New York City at the Institute for Architecture and Urban Studies, where students have the opportunity to study with internationally known professionals. For students interested in planning or preservation, internships can be established in local government through the Urban Observatory and the department.

Double majors with Urban Studies are quite frequent and the Arts/Engineering five-year degree, in which the student earns both B.A. (architecture) and B.S. (civil engineering), is highly recommended for some students.

The *art history major* offers a basic foundation in Western art and architectural history. Advanced courses are available at Muhlenberg, Moravian and Lafayette colleges through the Lehigh Valley Association of Independent Colleges. Special study in the Lehigh University art collection and museum studies are available.

In addition to these three major programs, individually structured programs may be planned, such as studio art with an emphasis on architectural design, art history with an emphasis on museum training, and architecture with an emphasis on planning, urban studies, or government.

Minor programs may be established with any member of the department; five courses are required.

Studio Art Major

Forty-two credit hours are required.

required preliminary courses (21 credit hours)

Art 5	Introduction to the Visual Arts (3)
Art 7	Studio Art Fundamentals (3)
Art 11	Basic Drawing (3)
Art 12	3-D Design (3)
Art 20	Color (3)
Art 23	Life Drawing (3)
Art 220	20th-Century Art (3)

plus one of the following (3 credit hours)

Art 111	Women in Art (3)
Art 210	20th-Century Architecture (3)
Art 219	19th-Century Painting (3)
Art 222	Seminar in Contemporary Art (3)

six required major courses (18 credit hours)
Art Studio: six courses, two at the advanced level.

Architecture Major

Sixty-two credit hours are required.

required preliminary courses (29 credit hours)

Arch 3	History of Architecture I (3)
Arch 4	History of Architecture II (3)
Arch 43	Introduction to Architectural Design (4)
Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Phys 11	Introductory Physics I (4)
Phys 12	Introductory Physics Laboratory I (1)
	two arts studio courses (except Art 161) (6)

required major courses (18 credit hours)

Arch 143	Intermediate Architectural Design I (3)
Arch 145	Structures and Systems (3)
Arch 210	20th-Century Architecture (3)
Arch 243	Intermediate Architecture Design II (3)
Arch 251	History of Urban Design (3)
Arch 343	Advanced Architectural Design (3)

five of the following (15 credit hours)

Arch 206	The Gothic Cathedral (3)
Arch 207	Renaissance Architecture (3)
Arch 209	Architecture 1750-1880 (3)
Arch 252	Physical Planning and Design (3)
Arch 342	Architectural Theory (3)
Art 261	Photography Workshop (3)
Clss 201	Archaeology: Lands of the Bible (3)
Clss 204	The Ancient City (3)
Eco 311	Environmental Economics (3)
Eco 312	Urban Economics (3)
Govt 306	Public Policy Process (3)
Hist 333	American Urban History to 1880 (3)
Hist 334	American Urban History, 1880 to the Present (3)
Psych 373	Sensation and Perception (3)
SR 368	The Urban Community (3)
Thtr 216	Advanced Scene Design (3)
US 363	Philadelphia: Development of a Metropolis (3)
US 365	Lehigh Valley: Development of a Regional Center (3)

For students contemplating graduate studies in architecture, Mech 1 and Mech 11 are strongly recommended.

Also recommended is that students fulfill the foreign language and culture option with a foreign language.

Art History Major

Forty-two credit hours are required.

required preliminary courses (9 credit hours)

Art 1	Introduction to Art History I (3) **and**
Art 2	Introduction to Art History II (3) **or**
Arch 3	History of Architecture I (3) **and**
Arch 4	History of Architecture II (3)
Art 5	Introduction to the Visual Arts (3)

one of the following (three credit hours)

Art 7	Studio Art Fundamentals (3)
Art 11	Basic Drawing (3)
Art 23	Life Drawing (3)
Arch 43	Introduction to Architectural Design (4)

one of the following (three credit hours)

Clss 82	Art and Archaeology of Greece (3)
Clss 201	Archaeology: Lands of the Bible (3)
Clss 203	Archaeology of Italy (3)

nine of the following (27 credit hours)
Arch 251, History of Urban Design (3); Art 175, Research, Collection and Historical Preservation (3); Arch 207, Renaissance Architecture (3); Arch 209, Architecture 1750-1880 (3); Arch 210, 20th-Century Architecture (3), Art 219, 19th-Century Painting (3); Art 220, 20th-Century Art (3); Art 222, Seminar in Contemporary Art (3); Arch 342, Architectural Theory. Completion of the art history major may require advanced courses at Muhlenburg, Moravian or Lafayette colleges through the Lehigh Valley Association of Independent Colleges.

Undergraduate Courses in Art

1. Introduction to Art History I (3) summer
Development of painting and sculpture primarily in the Western tradition from paleolithic to modern times. Redd

2. Introduction to Art History II (3) summer
Painting and sculpture primarily of Western civilization from the 16th Century to modern times. Redd

5. Introduction to the Visual Arts (3) fall
Principles of visual expression. Examples of art from various periods are examined in relation of their historical and cultural context, to their plastic organization and their significance as reflection of human experience. Redd, Gans

7. Studio Art Fundamentals (3) fall
Introduction to visual expression in drawing, design and color to understand studio practice in various art mediums. Emphasis on developing self-expression and creativity. Redd

11. Basic Drawing (3) fall-spring
Concepts and practice of building and representing three-dimensional form. Methods and media of drawing. Gans

12. Three-Dimensional Design (3) spring
Individual and group projects directed toward developing design in three dimensions. Exploration of materials and their application. Gans

20. Color (3) spring, alternate years
Projects directed toward building an awareness of color. Study and observation of the dynamics of color in theory and practice. Redd

23. Life Drawing (3) spring
Drawing from the live model as the fundamental experience towards building form. Gans

42. Graphic Communication (3) spring
An introduction to basic principles of visual

communication that guide the development of creative solutions in graphic design, printing, marketing, and advertising design. Viera

80. Leonardo da Vinci (3)
An examination of the Italian artist, architect, scientist and technologist in the context of Renaissance society and culture. Adams

111. Women in Art (3) fall
Survey of works and lives of women artists from the Renaissance to the present; changing role of women in relation to the art establishment. Visits to museums and artists' studios. Dialogs with successful and struggling women artists. Gans

123. Advanced Life Drawing (3) spring
Advanced drawing from the live model. Prerequisite: Art 23. May be repeated for credit. Gans

135. Painting (3) fall-spring
Painting in oil, acrylic or watercolor oriented toward developing individual creative expression combined with an understanding of the physical nature of the materials. Studio prerequisite: Art 7, 11 or 20 or consent of the department chairman. Redd, Gans

137. Introduction to Printmaking (3) fall
A structured course in mono print, relief "block" printing and basic etching. Introducing materials and tools, stressing creative application and the conceptual aspects of the media. Prerequisite: Art 11. Viera, Redd

138. Lithography and Intaglio (3)
History and principles of lithography (stone and aluminum plate) and intaglio printmaking (etching, aquatint, drypoint). Prerequisite: Art 11. Viera

161. Introduction to Photography (3)
Making and viewing of photographs. Basic camera and darkroom techniques, mechanics and materials. Class discussion and assignments in photographic history. Individual and group projects. Instruction directed toward development and use of photography as an art medium. Laboratory fee required. Prerequisite: consent of the department chairman. Barkan

211. Advanced Drawing (3) fall-spring
Projects in creative drawing designed to build on concepts and practices initiated in basic drawing and life drawing. May be repeated for credit. Prerequisites: Art 11 and 23. Redd, Gans

219. 19th-Century Painting (3) fall, alternate years
From Neoclassicism through the sequential movements of Romanticism, Naturalism, Impressionism, and Post-Impressionism in art of Europe and the United States. Redd

220. 20th-Century Art (3) spring, alternate years
The development of 20th-Century painting and sculpture from the foundations laid by Cezanne and Van Gogh through the revolutionary movements of cubism, expressionism, surrealism, abstract expressionism, and Pop. Illustrated lectures. Redd

222. Seminar in Contemporary Art (3) fall, alternate years
Recent aspects, developments in contemporary art. Exploring ideas and consequences of today's image-making. Studio workshops, readings, discussions and museum visits. Prerequisite: Art 2 or 5.

231. Advanced Design (3) fall-spring
Intensive design in a selected medium to provide the student with design experience in greater depth. Such media as fiber, mosaic, projection are among those that may be explored. Prerequisite: Art 7 or consent of the department chairman. Redd, Gans

235. Intermediate Painting (3) fall-spring
Problems in oil, watercolor, acrylic and mixed media. Prerequisite: Art 135. Redd, Gans

237. Intermediate Printmaking (3) fall-spring
Aluminum plate lithography and basic serigraphy. Further exploration in relief and intaglio printing. Survey of special topics, reading in the history of printmaking, problems in edition printing and today's print market. Prerequisite: Art 137 or 138. Viera

261. Photography Workshop (3) fall-spring
Projects and techniques for the more advanced student. Individual and group assignments including architectural applications. Prerequisites: Art 161 and consent of department chairman. Barkan

269. Special Topics in Art History (3) fall-spring
Directed projects for advanced students in the history of art or architecture. Prerequisite: consent of the department chairman.

273. Special Topics in Studio Practice (1-4) fall-spring
Individually directed projects for advanced students capable of undertaking independent creative work in applied art and photography. Prerequisite: consent of the department chairman.

335. Advanced Painting (3) fall-spring
Provides creative work in depth in a variety of painting media. Prerequisite: Art 233 or consent of the department chairman. May be repeated for credit. Redd, Gans

337. Printmaking Workshop (3) fall-spring
Independent experimentation and work in a chosen graphic media for the advanced student. Photographic applications, conceptual problems and mixed media. Conferences and critiques. May be repeated for credit. Prerequisite: Art 237 or consent of the department chairman. Viera

Undergraduate Courses in Architecture

3. History of Architecture I (3) fall
Architecture from prehistoric times to the Romanesque. Evolution of design, influence of technical achievements, relation to society and culture. Adams

4. History of Architecture II (3) spring
Architecture from the Gothic period to the present. Evolution of design, impact of industrialization, growth of the architectural profession. Adams

43. Introduction to Architectural Design (4) fall-spring
Basic architectural design. Function, selection and organization of spaces. Study of light, color and texture. Emphasis on creative concepts in relation to the built environment. Includes laboratory section in architectural drawing. Critiques and juries. Alvaré

143. Intermediate Architectural Design I (3) fall-spring
Concentrated projects in architectural design. Individual and team planning. Emphasis on actual problems of architectural form and expression in contemporary society. Conferences, critiques and juries. Prerequisite: Arch 43 or consent of the department chairman. Felder

145. Structures and Systems (3) fall
Structural forms and systems; methods and techniques of structural analysis. Terminology, formulae, problems in structure. Prerequisites: Math 21 and 22. Felder

206. The Gothic Cathedral (3)
The architectural form and social context of medieval ecclesiastical architecture in Europe; emphasis on the cathedrals of Chartres, Paris, Amiens, and Reims. Adams

207. Renaissance Architecture (3)
History of architecture and urban form during the Italian Renaissance. Major architects (Brunelleschi to Palladio), building types (church, palace, and fortress), and urban centers (Pienza, Rome, and Venice). Adams

209. Architecture 1750-1880 (3)
From the industrial revolution to the skyscraper. The nature of industrial architecture and its effect on cities and city planning. Emphasis on France, England, Germany, and America. Adams

210. 20th-Century Architecture (3) spring
History and theory of architecture from 1880. Emphasis on Frank Lloyd Wright, Le Corbusier, and Mies van der Rohe, and the problems of contemporary design. Adams, Felder

243. Intermediate Architectural Design II (3) fall-spring
More advanced study in architectural design and site planning. Increase in scope and complexity of projects. Critiques and juries. Prerequisite: Arch 143 or consent of the department chairman. Felder

251. History of Urban Design (3) fall
Historical development of urban design in the evolution of the city. Theories of city planning. Special emphasis is given to the social and economic parameters that determine physical design. Methods and practices used in the United States today. Seminar course. Prerequisite: Arch 43 or consent of the department chairman. Alvaré

252. Physical Planning and Design (3) spring
Solution of a physical planning problem with special emphasis on the relationship between the design functions and the social, economic and political programs under which the plan will develop. Studio course. Prerequisite: Arch 251. Alvaré

271. Special Topics in Architecture (3) fall-spring
Directed projects for advanced students in architecture or architectural criticism. Prerequisite: consent of the department chairman.

342. Architectural Theory (3) spring, alternate years
Relations of architectural or urban history, theory, and practice. May be repeated for credit as topic varies. Adams, Felder

343. Advanced Architectural Design (1-3) fall-spring
Individual study, project or other assignment for advanced students or majors capable of progress beyond general course content or requirement. Conferences and critiques. May be repeated for credit. Prerequisite: Arch 243 or consent of the department chairman. Alvaré

Museum Studies

175. Research, Collection and Historical Preservation (3) fall-spring
Introduction to the methods and procedures of research on art objects, historical sites, and documents. The nature of museum work in its practical aspects. Field trips and workshops. Each student completes a research report or equivalent. Prerequisite: consent of the department chairman. Viera

275. Museography and Museology (1-3) fall-spring
Theory and practice in contemporary museums and galleries. Research in the Lehigh University art collection. Curatorial problems in interpretation, display, cataloging and conservation. Each student completes a research report or equivalent. May be repeated for credit. Viera

375. Internship (3) fall-spring
Internship under professional supervision in the principal museum areas: curatorship, conservation, exhibition, interpretation, and administration in association with the Lehigh University Art Galleries, Historic Bethlehem, Inc., and Lehigh County Historical Society. Prerequisites: Art 175, 275 and consent of the department chairman.

Arts and Science

11. Sex Roles and Society: Continuity and Change (3)
Interdisciplinary study of sex roles—their existing character and impact upon individuals and institutions: masculine and feminine social roles in fiction; historical attitudes toward marriage and men's and women's work; research on sex differences; ideals of sex equality.

111. The American Character (3)
A chronological and methodological analysis of the shifting conceptions of "this new man, the American." Readings are selected from foreign and domestic observers ranging from Crevoeur to Christopher Lasch. Special attention is given to the conceptual difficulties of analyzing national character and to the debate over such an analysis. Dowling

Arts-Engineering

G. Mark Ellis, Ph.D., associate dean, College of Arts and Science, *curriculum director.*

The standard major for arts-engineers working towards a bachelor of science degree is applied science. This includes all of the science and engineering courses required in the freshman year and included in the pattern roster for the chosen field of engineering.

Arts-engineers with special interests outside engineering frequently combine another arts or science major with their engineering program. Interested students should consult with the curriculum director.

Recommended freshman year. Arts-engineering freshmen have the same roster of courses as do engineering freshmen, with the exception that the arts-engineering freshman takes Eco 1 in the second semester in place of an elective. Refer to the recommended freshman year, page 46.

Recommended professional sequences. Beginning with the sophomore year, the arts-engineering student will be guided by the appropriate pattern roster in the chosen field. The pattern roster shows the most effective way of combining arts and engineering courses to prepare for the last year in the branch of engineering chosen.

Although the minimum number of credit hours needed for the bachelor of arts degree is 120, a student in arts-engineering should expect to earn more than this in order to qualify for the bachelor of science degree in the chosen field of engineering at the end of the fifth year. The number of credits needed for both degrees is shown for each pattern roster.

Arts-Chemical Engineering

A total of 164 credit hours are needed for the bachelor of arts and the bachelor of science degree. For the freshman year, see page 46.

sophomore year, first semester (17 credit hours)	
Math 23	Analytical Geometry and Calculus III (4)
Chem 31	Equilibria (3)
ChE 43	Introduction to Chemical Engineering (4)
	distribution electives (6)

sophomore year, second semester (16 credit hours)
Math 205 Linear Methods (3)
ChE 44 Chemical Process Analysis I (4)
Chem 187 Thermodynamics (3)
distribution electives (6)

junior year, first semester (17 credit hours)
Chem 51 Organic Chemistry (3)
Chem 53 Organic Chemistry Laboratory (1)
ChE 141 Chemical Process Analysis II (4)
distribution electives (9)

junior year, second semester (18 credit hours)
Chem 52 Organic Chemistry (3)
ChE 142 Chemical Process Analysis III (4)
Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Laboratory II (1)
distribution electives (6)

senior year, first semester (15 credit hours)
Chem 191 Physical Chemistry (3)
electives for engineering major (6)*
distribution electives (6)

senior year, second semester (16 credit hours)
ChE 200 Chemical Engineering Laboratory I (3)
ChE 210 Chemical Engineering Thermodynamics (4)
elective for engineering major (6)*
distribution elective (3)

summer
ChE 100 Industrial Employment

*These electives are chosen with the chemical engineering adviser.

Arts-Civil Engineering

A total of 163 credit hours are needed for the bachelor of arts and the bachelor of science degree. For the freshman year, see page 46.

sophomore year, first semester (15 credit hours)
Math 23 Analytical Geometry and Calculus III (4)
Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Laboratory II (1)
distribution electives (6)

sophomore year, second semester (17 credit hours)
Math 205 Linear Methods (3)
Mech 1 Statics (3)
CE 11 Engineering Graphics (2)
distribution electives (9)

junior year, first semester (17 credit hours)
Mech 11 Mechanics of Materials (3)
CE 40 Plane Surveying (3)
CE 115 Probability and Statistics in Civil Engineering (2)
distribution electives (9)

junior year, second semester (15 credit hours)
Met 92 Structure and Properties of Materials (3)
CE 121 Mechanics of Fluids (3)
distribution electives (9)

summer
CE 41 Engineering and Higher Surveying (3)

senior year, first semester (18 credit hours)
CE 143 Soil Mechanics (4)
CE 159 Structural Analysis I (4)
CE 222 Hydraulic Engineering (4)
Geol 101 Geology for Engineers (3)
Mech 104 Dynamics and Vibrations (3)

senior year, second semester (17 credit hours)
CE 160 Structural Design (4)
CE 170 Environmental Engineering (3)
CE 200 Engineering Planning and Economics (4)
elective (3)*
distribution electives (3)

summer
CE 100 Summer Employment

Eight weeks of summer employment should precede the fifth year. Consult the department chairperson.

*Electives that require approval of the civil engineering department chairperson.

Arts-Computer Engineering

A total of 157 credit hours are needed for the bachelor of arts and bachelor of science degrees. For the freshman year, see page 46.

sophomore year, first semester (16 credit hours)
Math 23 Analytical Geometry and Calculus III (4)
Phys 21 Introductory Physics (4)
Phys 22 Introductory Physics Laboratory II (1)
ECE 83 Principles of Computer Engineering (4)
distribution elective (3)

sophomore year, second semester (15 credit hours)
ECE 102 Structured Programming† (3)
Math 205 Linear Methods (3)
distribution electives (9)

junior year, first semester (16 credit hours)
ECE 81 Principles of Electrical Engineering† (4)
Math 231 Probability and Statistics (3) *or*
Math 309 Theory of Probability (3)
distribution electives (9)

junior year, second semester (16 credit hours)
ECE 116 Software Engineering (3)
ECE 108 Signals and Systems (4)
distribution electives (9)

senior year, first semester (14 credit hours)
ECE 121 Electronic Circuits Laboratory (2)
ECE 123 Electronic Circuits (3)
ECE 125 Circuits and Systems (3)
elective (3)
distribution elective (3)

senior year, second semester (14 credit hours)
ECE 138 Digital Systems Laboratory (2)
ECE 201 Computer Architecture (3)
ECE 317 Discrete Structures (3)
approved elective* (3)
distribution elective (3)
ECE 100 Industrial Employment

fifth year
See program description for computer engineering, page 129.

*These electives require approval of the department of electrical and computer engineering. They are subjects in the area of science and technology, not restricted to offerings of the department.

†These courses may be interchanged in the student's schedule if necessary.

Arts-Electrical Engineering

A total of 158 credit hours are needed for the bachelor of arts and bachelor of science degrees. For the freshman year, see page 46.

sophomore year, first semester (15 credit hours)

Math 23	Analytical Geometry and Calculus III (4)
Phys 21	Introductory Physics (4)
Phys 22	Introductory Physics Laboratory II (1)
	distribution electives (6)

sophomore year, second semester (16 credit hours)

Math 205	Linear Methods (3)
Mech 103	Principles of Mechanics (4)
	distribution electives (9)

junior year, first semester (17 credit hours)

ECE 81	Principles of Electrical Engineering (4)
ECE 83	Principles of Computer Engineering (4)
Math 231	Probability and Statistics (3) **or**
Math 309	Theory of Probability (3)
	distribution electives (6)

junior year, second semester (16 credit hours)

ECE 108	Signals and Systems (4)
	approved elective* (3)
	distribution electives (9)

senior year, first semester (14 credit hours)

ECE 121	Electronic Circuits Laboratory (2)
ECE 123	Electronic Circuits (3)
ECE 125	Circuits and Systems (3)
	approved elective* (3)
	distribution elective (3)

senior year, second semester (15 credit hours)

ECE 126	Physical Electronics (3)
ECE 136	Electromechanics Laboratory (2)
ECE 138	Digital Systems Laboratory (2)
ECE 202	Introduction to Electromagnetics (2)
	approved elective* (3)
	distribution elective (3)
ECE 100	Industrial Employment

fifth year
See program description for electrical engineering, page 129.

*These electives require approval of the department of electrical and computer engineering. Approved electives are subjects predominantly in the area of science and technology. They are not restricted to offerings in the department. Students must choose at least one elective in mathematics, and at least one elective in either materials, thermodynamics, fluid mechanics, or physical chemistry.

Arts-Engineering Physics

A total of 160 credit hours are needed for the bachelor of arts and bachelor of science degrees.

Arts-engineering physics students complete, during the first four years, the physics major under the guidance of the chairperson of the department of physics.

Arts-Industrial Engineering

A total of 158 credit hours are needed for the bachelor of arts and bachelor of science degrees. For the freshman year, see page 46.

sophomore year, first semester (16 credit hours)

Math 23	Analytical Geometry and Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
IE 7	Deterministic Models (4)
	distribution elective (3)

sophomore year, second semester (15 credit hours)

IE 110	Engineering Probability (3)
IE 18	Data Processing Fundamentals (3)
	distribution electives (9)

junior year, first semester (15 credit hours)

Math 205	Linear Methods (3)
IE 205	Engineering Statistics (3)
	engineering science elective (3)*
	distribution electives (6)

junior year, second semester (16 credit hours)

IE 206	Operation Research Techniques (4)
	engineering science electives (6)*
	distribution electives (6)

senior year, first semester (16 credit hours)

IE 101	Fundamentals of Manufacturing Engineering (4)
	engineering science elective (3)*
	distribution electives (9)

senior year, second semester (16 credit hours)

IE 104	Work Systems (4)
	engineering science electives (6)*
	electives (3)
	distribution elective (3)

summer

IE 100	Industrial employment should precede the fifth year. Consult the chairperson of the department of industrial engineering.

*Note: Engineering science electives must be approved by the department of industrial engineering adviser.

Arts-Mechanical Engineering and Mechanics

A total of 158 credit hours are needed for the bachelor of arts and the bachelor of science degrees. For the freshman year, see page 46.

sophomore year, first semester (17 credit hours)

Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Math 23	Analytical Geometry and Calculus III (4)
ME 12	Engineering Drawing and Descriptive Geometry (2)
	distribution electives (6)

sophomore year, second semester (15 credit hours)

Mech 1	Statics (3)
Math 205	Linear Methods (3)
	distribution electives (9)

junior year, first semester (15 credit hours)

ME 104	Thermodynamics (3)
Mech 11	Mechanics of Materials (3)
	distribution electives (9)

junior year, second semester (15 credit hours)

Mech 102	Dynamics (3)
ME 21	Mechanical Engineering Laboratory I (1)
ME 231	Fluid Mechanics (3)
ECE 81	Principles of Electrical Engineering (4)
ECE 162	Electrical Laboratory (1)
ME 105	Thermodynamics II (3)

senior year, first semester (15 credit hours)

Met 63	Engineering Materials and Processes (3) *or*
Met 91	Elements of Materials Science (3)
Math 208	Complex Variables *or*
Math 231	Statistical Inference (3)
Mech 203	Advanced Strength of Materials (3)
	distribution electives (6)

senior year, second semester (17 credit hours)

ME 101	Mechanical Engineering Design (1)
ME 151	Mechanical Elements (3)
ME 242	Mechanical Vibrations (3)
ME 121	Mechanical Engineering Laboratory II (1)
	distribution electives (6)
	elective (3)

Arts-Metallurgy and Materials Engineering

A total of 163 to 165 credit hours are needed for the bachelor of arts and bachelor of science degrees, depending on the option selected. For the freshman year, see page 46.

sophomore year, first semester (16 credit hours)

Met 63	Engineering Materials and Processes *or*
Met 91	Elements of Materials Science (3)
Math 23	Analytical Geometry and Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Met 10	Metallurgical Laboratory (1)
	distribution elective (3)

sophomore year, second semester (15 credit hours)

Mech 1	Statics (3)
Math 205	Linear Methods (3) *or*
Math 231	Statistical Inference (3)
	distribution electives (9)

junior year, first semester (15 credit hours)

Chem 207	Metallic Elements (3)
Met 207	Electronic and Crystal Structure (3)
Met 210	Metallurgical Thermodynamics (3)
Mech 11	Mechanics of Materials (3)
	distribution electives (3)

junior year, second semester (15-16 credit hours)

Met 208	Phase Diagrams and Transformations (3)
Met 218	Mechanical Behavior of Materials (3)
ECE 81	Principles of Electrical Engineering (4) *or*
Phys 31	Introduction to Quantum Mechanics (3)
	distribution electives (6)

senior year, first semester (15 credit hours)

Met 307	Materials Engineering I (3)
ChE 60	Unit Operations Survey (3)
	distribution electives (9)

senior year, second semester (17-18 credit hours)

ME 166	Procedures for Mechanical Design *or*
Mech 102	Dynamics (2-3)
Met 101	Professional Development (2)
Met 304	Extractive Metallurgy I (4)
	distribution electives (6)
	elective (3)

summer

Met 100	Industrial employment should precede the fifth year. Consult the chairperson of the department.

Note: Students interested in the industrial or research options should consult with the department chairperson prior to their fourth year. Students selecting the research option should elect Met 240, Research Techniques, in the second semester of the senior year.

Arts-Master of Business Administration Program

The arts-master of business administration two-degree program is a special opportunity offered by the College of Arts and Science. See page 35 for a description.

Asian Studies

The East Asian Studies minor program is an opportunity in the College of Arts and Science. A description of the program is found on page 38.

Astronomy

George E. McCluskey, Ph.D. *professor*

Astronomy is offered in the department of mathematics.

1. The Solar System (3) fall
Survey of our knowledge of the solar system. Apollo lunar missions. Mariner missions to Mercury, Venus and Mars. Viking missions to Mars. Missions to Jupiter and Saturn.

2. Stellar Astronomy (3) spring
Survey of our knowledge of stars and stellar systems. Observation and theory of pulsars, quasars, X-ray sources, gamma-ray sources, neutron stars and black holes.

211. Stellar Structure and Evolution (3) fall, even-numbered years
Physical processes in stellar interiors. Theory of stellar evolution and interpretation of observations. Binary star evolution. Theory of novae and supernovae. Prerequisites: Math 23 or 32 or 44, previously or concurrently, and Phys 21.

221. Stellar Atmospheres (3) fall, odd-numbered years
Observation and theory of stellar spectra. Model atmospheres and chemical abundances. Extended atmospheres, stellar winds and mass loss. Theory of gaseous nebulae. Prerequisites: Math 23 or 32 or 44, previously or concurrently, and Phys 21.

232. High-Energy Astrophysics (3) spring odd-numbered years
Observation and theory of X-ray and gamma-ray sources, quasars, pulsars, radio galaxies, neutron stars, black holes. Results from ultraviolet, X-ray and gamma-ray satellites. Prerequisites: Math 23 or 32 or 44, previously or concurrently and Phys 21.

242. Relativity and Cosmology (3) spring, even-numbered years
Special and general relativity. Schwarzschild and Kerr black holes. Supermassive stars. Relativistic theories of the origin and evolution of the universe. Prerequisites: Math 23 or 32 or 44, previously or concurrently, and Phys 21.

Athletics and Recreation

Professor. William B. Leckonby, B.S., *director of intercollegiate athletics and recreation.*
Assistant professors. John N. Covert, B.S.; Gerald G. Leeman, B.A.; Gregory J. Schulze, M.S.; B. Thayer Turner, B.S.; John C. Whitehead, B.S.
Instructors. N. Craig Anderson, M.S., *business manager;* Karen A. Adams, B.S.; Judith T. Baxter, B.S.; Steven J. Damico, M.S.; William Donahue, M.A.; Barry J. Fetterman, B.S.; J. Bruce Gardiner, M.Sc.; Wayne A. Grube, B.S.; Brian Hill, B.A.; Kevin Kopp, B.A.; Muffet McGraw, B.S.; Charles R. McNaron, B.S.; Salvatore V. Mentesana, B.A.; Stanley R. Schultz, B.A.; Thomas J. Rogish, M.Ed.; Joseph D. Sterrett, M.Ed.; Walter J. Whitehead, B.A.

The department of intercollegiate athletics and the department of recreation and intramural sports supervise the entire field of intercollegiate athletics, recreation and intramurals at the university. Activities consist of intercollegiate athletics, recreation, and intramural sports.

Facilities are afforded in Taylor Gymnasium, Grace Hall, Taylor Field, and Sayre Park Field, the latter an area of seven acres located above the Lookout on top of South Mountain and only a short distance from many residential facilities. The Saucon Valley athletic complex is located south of the campus. The approximately 600 acres there accommodate the following facilities: all-weather quarter-mile track, nine all-weather tennis courts, several lacrosse and soccer fields, three football practice fields, Varsity House, a baseball diamond, twelve to sixteen intramural fields, and a football field. The area is the site of the Stabler Athletic and Convocation Center that seats 6,000. Almost all outdoor intramural sports contests and all upperclass intramural activities are held on the Saucon fields; a shuttle bus service is provided.

The Saucon Valley athletic complex also features indoor squash courts. The Philip Rauch Field House includes an indoor track, as well as tennis and basketball courts.

Intercollegiate Athletics

The department offers the opportunity for undergraduate men and women to participate in intercollegiate competition both at home and away with institutions that are Lehigh's traditional rivals and as well as other institutions.

The intercollegiate program consists of varsity teams in football, cross country, soccer, wrestling, basketball, swimming, tennis, track, baseball, golf, lacrosse, hockey, squash, winter track, and rifle. In addition, there are junior varsity and/or freshman teams in some of the above.

The women's athletic program includes competition at the intercollegiate level with other colleges in field hockey, volleyball, basketball, swimming, tennis, softball, and lacrosse.

Intramural Sports and Recreation

The department supervises the intramural sports and the recreational physical activities of students. The aim is to insure the health and physical development of students.

Through its program of intramural sports, the university endeavors to maintain among its students a high degree of physical fitness, to establish habits of regular and healthful exercise, to foster the development of such valuable byproducts as self-confidence, good sportsmanship, and a spirit of cooperation, and to provide each student with ample opportunity for acquiring an adequate degree of skill in sports of the type in which participation can be continued after graduation.

Prior to arrival on campus, each new or transfer student must submit to the Health Service a record of physical examination filled in and signed by a physician, and a completed health history form. All such forms are checked by the Health Service and each student is thereby classified for activities in accordance with current health status.

A wide variety of courses of instruction are available on a voluntary basis. Courses stress the history, rules, fundamentals and playing situations of a sport. Instruction and competition for women students are available in a number of activities. Individual sports are offered on a voluntary basis.

In Taylor Gymnasium, opportunity is offered in the following activities: recreational swimming, beginner's swimming, dance, physical development, boxing, apparatus exercises, life-saving, controlled weight training, badminton, judo, karate, and sports fundamentals.

A comprehensive program in intramural sports is sponsored for the student body including fraternity, residence hall, and independent groups in touch football, tennis, soccer, badminton, boxing, individual athletics, basketball, swimming, wrestling, track, softball, squash, volleyball, and recreative games. Students are encouraged to participate in these sports, and awards are given for excellence in performance.

The university Health Service provides medical treatment. If a student is injured while engaged in any sport he or she must report as soon as possible to the Health Service, located in Johnson Hall.

All students, in order to compete in intercollegiate activities, must sign up for the student insurance program or have their own insurance program that covers athletic injuries.

Instructional Opportunities

The following programs and activities are open to all students: nonswimmers' program, basic swimming, life saving, water safety instruction, scuba diving (fee), fencing, basic tennis, intermediate tennis, advanced tennis, modern dance, physical fitness, personal defense (fee), stunts and tumbling, basketball, volleyball, softball, squash, running, skating (fee), and skiing (fee).

No credit is given for these courses; they are voluntarily elected, subject to approval of the department. A periodic announcement is made.

Biology

Professors. Saul B. Barber, Ph.D.; Sidney S. Herman, Ph.D.; Steven Krawiec, Ph.D.; Richard G. Malsberger, Ph.D.
Associate professors. Barry Bean, Ph.D., *chairperson;* David L. Cundall, Ph.D.; Bland S. Montenecourt, Ph.D.; Hayden N. Pritchard, Ph.D.
Assistant professors. Bruce R. Hargreaves, Ph.D.; Murray Itzkowitz, Ph.D.; Jon I. Parker, Ph.D.; Craig E. Williamson, Ph.D.
Adjunct associate professor. Patricia T. Bradt, Ph.D.

The biology department offers both the bachelor of arts and the bachelor of science degrees. The principal differences between the two are:

1. The B.A. course of study requires the student to complete the distribution requirements of the College of Arts and Science in addition to the requirements of the biology department.
2. The B.S. course of study requires that, in addition to the requirements of the biology department, the

student complete a total of thirty credit hours outside the fields of natural science and mathematics in accordance with the rules of the college.

3. The B.A degree has a total of sixty-two credit hours in the major requirements as compared with eighty-three credit hours in the B.S. program.

The B.A. degree in biology is not designed specifically for preprofessional training but it does exceed the minimum requirements for entrance into biology graduate programs as well as admission to medical, dental, and allied professional colleges. The B.A. degree is recommended for those students who desire a broad knowledge of biology combined with the cultural background of the distribution requirements established by the College of Arts and Science.

The B.S. is designed specifically for optimal scientific preparation facilitating entry into professional graduate training in biology as well as medicine, dentistry, and other allied fields. Such preprofessional training is obtained at the cost of a reduction in the number of humanities and social sciences that a student will be able to take during a normal four-year undergraduate program. Students should, therefore, consider carefully before committing themselves to either program. An initial choice of one or the other program is reversible, but this becomes more difficult after the freshman year.

Special programs. Students may apply for admission to an accelerated B.A.-doctor of medicine program and a B.A.-doctor of medical dentistry program. A six-year B.A.-M.D. program is offered in conjunction with the Medical College of Pennsylvania, and a seven-year B.A.-D.M.D. program is offered in conjunction with the University of Pennsylvania School of Dental Medicine. Students in these programs receive a B.A. from Lehigh and a graduate degree from the designated professional school within a six- or seven-year period. For details concerning admission to these programs, see Health Professions, Section III.

Required Courses in Biology

		B.A.	B.S.
Biol 21	Principles of Biology	3	3
Biol 22	Introduction to Biology Laboratory	1	1
Biol 28	Genetics	3	3
Biol 331	Non-Vascular Plants **or**	3	3
Biol 332	Evolution of Vascular Plants	3	3
Biol 134	Comparative Vertebrate Anatomy **or**	4	4
Biol 303	Invertebrate Zoology	3	3
Biol 135	Microbiology	3	3
Biol 320	Cell Physiology **or**	3	3
Biol 322	Animal Physiology	3	3
Biol 306	Ecology **or**		
Biol 317	Evolution	3	6
Biol	electives	6	9
		29 or 28	35 or 34

*Note: Students in the bachelor of science program in biology take both Biol 306, Ecology, and Biol 317, Evolution.

In addition to biology courses listed in the catalog, electives may be selected from approved cognate courses in other departments.

additional required courses for the B.A. program

Math 41	BMSS Calculus (3)
Math 44	BMSS Calculus (3)
Math 42	BMSS Probability (3) **or**
Math 43	BMSS Linear Algebra (3)
Chem 21, 22	Chemical Principles and Laboratory (5)
Chem 51, 52, 55	Organic Chemistry and Laboratory (8)
Chem 31	Chemical Equilibria in Aqueous Systems or
Chem 194	Physical Chemistry (3)
Phys 11, 12	Introductory Physics and Laboratory (5)
Phys 13, 14	General Physics and Physics Laboratory (4)

Recommended B.A. Science Sequence

freshman year

Biol 21, 22	Principles of Biology and Laboratory (4)
Biol 28	Genetics (3)
Chem 21, 22	Chemical Principles I and Laboratory (5)
Math 41, 44	BMSS Calculus (6)

sophomore year

Chem 51, 52, 55	Organic Chemistry and Laboratory (8)
Math 42	BMSS Probability (3) **or**
Math 43	BMSS Linear Algebra (3)
Biol 331	Non-Vascular Plants (3) **or**
Biol 332	Evolution of Vascular Plants (3)
Biol 134	Comparative Vertebrate Anatomy (4) **or**
Biol 303	Invertebrate Zoology (3)

junior year

Phys 11, 12	Introductory Physics and Laboratory (5)
Phys 13, 14	General Physics and Laboratory (4)
Biol 135	Microbiology (3)
Biol 306	Ecology (3) **or**
Biol 317	Evolution (3)
Biol	elective (3)

senior year

Chem 31	Chemical Equilibria (3) **or**
Chem 194	Physical Chemistry (3)
Biol 320	Cell Physiology (3) **or**
Biol 322	Animal Physiology (3)
Biol	elective (3)

additional required courses in the B.S. program

Math 21, 22, 23	Analytic Geometry and Calculus (12) **or**
Math 41, 44, 42, 43	BMSS Calculus, Probability and Linear Algebra (12)
Chem 21	Introductory Chemical Principles (4)
Chem 22	Chemical Principles Laboratory (1)
Chem 51, 52	Organic Chemistry (6)
Chem 55	Organic Chemistry and Laboratory (2)
Chem 31	Chemical Equilibria (3)
Chem 187 or 194	Physical Chemistry (3)
Phys 11	Introductory Physics I (4)
Phys 12	Introductory Physics Laboratory I (1)
Phys 13	General Physics (3)
Phys 14	General Physics Laboratory (1)
Geol 1	Principles of Geology (3)
elective	any course in the natural sciences or mathematics (3)

and one of the following:

Psych 1	Introduction to Psychology (3)

Psych 113	Psychological Research and Statistics (3)
Phil 261	Philosophy of the Natural Sciences (3)

and thirty credit hours of non-science electives in accordance with the rules of the college.

Recommended B.S. Science Sequence

freshman year

Biol 21, 22	Principles of Biology and Laboratory (4)
Biol 28	Genetics (3)
Math 21, 22	Analytical Geometry and Calculus I, II (8) or
Math 41, 44	BMSS Calculus (6)
Chem 21, 22	Chemistry Principles I and Laboratory (5)

sophomore year

Chem 51, 52, 55	Organic Chemistry and Laboratory (8)
Math 23	Analytic Geometry and Calculus III (4) or
Math 42, 43	Probability Linear Algebra (6)
Biol 331	Non-Vascular Plants (3) or
Biol 332	Evolution of Vascular Plants (3)
Biol 134	Comparative Vertebrate Anatomy (4) or
Biol 303	Invertebrate Zoology (3)
elective	Psych 1, Introduction to Psychology (3), or Psych 113, Psychological Research and Statistics (3) or Phil 261, Philosophy of the Natural Sciences (3)

junior year

Geol 1	Principles of Geology (3)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Phys 13, 14	General Physics and Laboratory (4)
Biol 135	Microbiology (3)
Biol 306	Ecology (3)
Biol 317	Evolution (3)
Biol	elective (3)

senior year

Chem 31	Chemical Equilibria (3)
Chem 187 or 194	Physical Chemistry (3)
Biol 320	Cell Physiology (3) or
Biol 322	Animal Physiology (3)
Biol	electives (6)
elective	natural science or mathematics (3)

Undergraduate Courses in Biology

1. Biology and Society (3)
Principles and implications of modern biological thought for non-science, business, and engineering majors. Areas of high social relevance, such as genetics, behavior, populations, and environment. May not be substituted for or taken in addition to Biol 21.

21. Principles of Biology (3) fall-spring
Introduction to biology by study of selected principles. Topics covered include cell structure and function, plant and animal structure and function, diversity and evolution of organisms. Three lectures per week.

22. Introduction to Biology Laboratory (1) fall-spring
Laboratory observations and experiments to illustrate how biological information is acquired. Designed primarily as a laboratory to accompany Biol 21. Prerequisite: Biol 21 previously or concurrently. One three-hour laboratory per week. Graded only pass-fail.

28. Genetics (3) fall-spring
Organization, replication, and transmission of hereditary information. Mechanisms of expression and modification of genes.

134. Comparative Vertebrate Anatomy (4) fall
A course in vertebrate zoology with emphasis on the study of homologous body structures in the various vertebrate classes and their relationship to the functional demands of habit and environment in each class. Detailed dissections of representative vertebrates are made in the laboratory. Two lectures and two laboratory periods. Prerequisites: Biol 21 and 22, or equivalent; sophomore standing.

135. Microbiology (3) fall-spring
The appearance, physiology, and taxonomy of prokaryotes. Two lectures and one laboratory period. Prerequisite: Chem 52, previously or concurrently.

151. Vertebrate Field Biology (3)
Field studies on the diversity and distribution of local vertebrates. Emphasis on methods of sampling, collecting and identifying populations and on measurement of the physical environment. Two lectures per week, laboratories on Friday afternoon and on Saturday during the first seven weeks. Prerequisite: Biol 21, 22 and consent of the department chairperson. Enrollment limited.

191. (Geol 191) Environmental Science Seminar (1)
Seminar on current problems and developments in environmental science. May be repeated for credit. Prerequisite: sophomore standing.

Minor in Biology

A minor in biology may be achieved by completing the following requirements:

Biol 21, 22	Principles of Biology and Laboratory (4)
Chem 21, 22	Chemical Principles and Laboratory (5)
Chem 51	Organic Chemistry (3)
Phys 11, 12	Introductory Physics and Laboratory (5)
Math 41	BMSS Calculus (3)
Biol	electives (12)
	total credits 32

For Advanced Undergraduates and Graduate Students

221. Undergraduate Research (3)
Laboratory work, field work, or both, depending upon the interest and competence of the student. Prerequisites: junior standing and consent of the department chairperson.

231. Natural History and Ecology (3) summer
A concentrated course in recognition of species of plants and animals and study of their interrelationships in natural and altered environments. Lectures and seminars in use of keys and preservation of collections. Designed for secondary school teachers in life sciences. Prerequisites: graduate standing or consent of the department chairperson.

232. Natural History and Ecology Workshop (3)
Field and laboratory work in natural history and ecology. Must be taken concurrently with Biol 231.

241. Ecology of Wetlands (6) summer
Study of plants and animals of wetlands areas and their interrelationships with the environment. The importance of the wetlands to the marine environment and methods of conservation. Independent study will form part of the

course. Primarily designed for secondary school teachers of the sciences. Prerequisite: consent of the department chairperson. (Offered only at The Wetlands Institute.)

251. Frontiers of Biology (1) fall, spring
Special seminars, discussions and library research in curriculum development projects focusing on and correlated with the current theme of the LVAIC Frontiers in Biology seminar series. May be repeated for credit. Late afternoon and evening session at each of three LVAIC campuses. Prerequisite: consent of the department chairperson.

261. Special Topics in Biology (1-3)
Research, conferences and reports on selected topics not covered in the general undergraduate offerings. May be taken more than once for credit. Prerequisite: consent of the department chairperson.

262. Special Topics in Biology (1-3)
Continuation of Biol 261.

303. Invertebrate Zoology (3) spring
Detailed survey of representative invertebrates. Anatomical and histological examination of selected types. Concepts of evolution and speciation. Two lectures and one laboratory. Prerequisite: two semesters of biology, one with laboratory.

306. Ecology (3) fall-spring
Basic principles and applications of ecological interrelationships. Examination of ecological phenomena at the individual, population, community, and ecosystem levels. Two lectures and one laboratory period or field trip. Prerequisite: two semesters of biology, one with laboratory.

309. Aquatic Biology (3) alternate years
Physical, chemical and biological aspects of fresh-water environment, including cyclic and seasonal changes. Major groups of organisms and their interactions. Two lectures and one laboratory or field trip. Prerequisites: Biol 21 and 22 or equivalent.

311. Water Pollution Biology (3) fall, alternate years
Water pollution issues and fundamental principles of aquatic ecology; field trips to impacted lakes and streams in Pennsylvania. Strip-mining, stream siltation, acid mine drainage, eutrophication, acid rainfall, and other topics. Prerequisite: Biol 306, or consent of department chairperson.

313. General Histology (3) fall-spring
The techniques of preservation and preparation of animal and plant tissues for microscopical study; comparative studies of fresh and preserved tissues. One lecture and two laboratory periods. Prerequisite: Biol 21 and 22 or equivalent; Biol 134 or equivalent recommended.

314. Vertebrate Embryology (3) spring
A study of reproduction from germ cell formation through establishment of the principal organ systems of the vertebrate body. Various mechanical and physiological problems confronting the growing embryo are considered, and direct observations of whole mounts, sections, and living material are made in the laboratory. Two lectures and one laboratory period. Prerequisite: Biol 134 or equivalent.

315. Terrestrial Ecology (3) fall
Structural and functional aspects of terrestrial communities. Ecosystem analysis to evaluate flux of carbon and energy through various biomes. Two lectures and one laboratory or field trip. Prerequisite: Biol 306, or consent of the department chairperson.

317. Evolution (3) spring
Mechanisms of evolution, emphasizing natural selection, genetic structure and variation of populations, and isolation. Origin of species and higher taxa. Rates of evolution, extinction. Prerequisite: Biol 28 and an additional semester of biology, or consent of the department chairperson.

319. Reproduction and Mating Systems (3)
Patterns of reproduction and sexuality in plants and animals with emphasis on natural selection and ecological principles. Topics include hermaphroditism, neoteny, larval forms, parental investment, complex life cycles, population structure. Lectures, discussions, readings from textbook, student reports. Prerequisites: Biol 28; Biol 306 or 317.

320. Cell Physiology (3) fall
The fundamental processes of life at the cellular level, including permeability and related membrane phenomena, enzymatic transformations, respiration, photosynthesis, gene function, bioelectricity, and other aspects of neuron function, contractility and other kinds of protoplasmic motility. Two lectures and one laboratory. Prerequisites: two semesters of biology, at least one with laboratory; Chem 52 or consent of the department chairperson.

322. Animal Physiology (3) spring
The physiology of organs and organ systems in animals. Emphasis on mammalian systems, but lower vertebrates and invertebrates are also included. Functions studied include digestion, nutrition, metabolism, excretion, respiration, circulation, locomotion, nervous and chemical coordination. Two lectures and one laboratory. Prerequisites: two semesters of biology, at least one with laboratory; Chem 52 or consent of the department chairperson.

325. Advanced Genetics (3) fall
Lectures and student contributions on selected aspects of genetics, with emphasis on the molecular approach. The structure, organization, and replication of genes. The expression of genetic information and its regulation in cellular and developmental biology. Prerequisite: Biol 28 or consent of the department chairperson.

327. Cellular Regulation (3)
Systems of regulation of cellular activity and multicellular coordination; cell replication, movements and integration of activity within and between cells. Two lectures, one laboratory. Prerequisite: Biol 21 or 28.

329. Herpetology (3)
Biology of amphibians and reptiles. Two lectures and one laboratory or field trip per week. Prerequisite: Biol 21 and consent of the department chairperson. Open only to students who have not received credit for Biol 429.

331. Non-Vascular Plants (3) fall
A comparative study of the ontogenetic and phylogentic development of algae, fungi and bryophytes. The life cycles and ecological importance of representative organisms are examined. Two lectures and one laboratory. Prerequisite: Biol 21.

332. Evolution of Vascular Plants (3) spring
A comparative study of the ontogenetic and phylogenetic development of vascular plants. The life cycles, ecological importance and cellular morphology of the higher plants are examined. Emphasis on the plants of Pennsylvania. Two lectures and one laboratory. Prerequisite: Biol 21.

333. Symbiosis (3) fall
Consideration of factors governing symbiotic relationships, including phoresis, commensalism, parasitism, and mutualism. Lectures and demonstrations emphasizing the theoretical and applied aspects of morphological and physiological adaptation, nutrient assimilation and metabolism, development, host

reactions, and the dynamics of host-symbiont interactions are presented. Laboratory experiments are designed to acquaint the student with techniques, evaluation of data, and to demonstrate principles. Prerequisite: Biol 21. Two lectures and one laboratory.

335. (Psych 335) Animal Behavior (3) spring
Discussion of the behavior of invertebrates and vertebrates and analysis of the physiological mechanisms responsible for behavioral actions. Emphasis on perception, environmental stimuli, and adaptive value of specific behavior patterns. Prerequisite: Biol 21 or consent of the department chairperson.

336. Animal Behavior Laboratory (2)
Experiments and field observations illustrating principles discussed in Biol 335. Emphasis on observing animals, performing experiments, collecting and analyzing data, and individual research. Six hours of laboratory per week. Corequisite: Biol 335 and consent of the department chairperson. Limited enrollment.

337. (Psych 337) Sociobiology (3)
Social systems of vertebrate and invertebrate groups. Emphasis on ecological and evolutionary factors that influence social behavior. Prerequisite: Biol 21 or consent of department chairperson.

339. Microbial Physiology (3) spring
Physiology of bacteria, yeast and fungi. Antibiotics: their biosynthesis and effect on microbial cell structure and function. Prerequisite: Biol 135, and either Biol 320 or Chem 371 and 372.

341. Biology of Marine Animals (6) summer
Emphasis on comparative morphology and physiology of marine animals. Field trips for ecological observation and collection as well as anatomical study and physiological experimentation. Prerequisite: consent of the department chairperson and two semesters of biology. (Offered only at The Wetlands Institute.)

343. Microbial Ecology (6)
Qualitative and quantitative study of bacteria and the physical and chemical features of their environments. Simulation of natural habitats in the laboratory to illustrate growth, competition, and succession of organisms. Prerequisite: Biol 135 or equivalent course. Offered at The Wetlands Institute.

353. Virology (3) spring
A lecture course on bacterial and animal viruses including taxonomy, physical and chemical properties, and the biochemical transformations of infected cells. Prerequisite: a course in microbiology or biochemistry.

361. Sanitary Microbiology (3) spring
Laboratory, field work, and reports on the microbiology of water supplies, waste disposal, and food processing. Two lectures and one laboratory. Prerequisite: one semester of microbiology.

371. (Chem 371) Elements of Biochemistry I (3) fall
A general study of carbohydrates, proteins, lipids, nucleic acids, and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Prerequisite: one year of organic chemistry.

372. (Chem 372) Elements of Biochemistry II (3) spring
Dynamic aspects of biochemistry; enzyme reactions including energetics, kinetics, and mechanisms; metabolism of carbohydrates, lipids, proteins and nucleic acids; photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisite: Chem 371.

375. (Psych 375) Physiological Psychology (3) fall
The physiological basis of behavior, both human and animal. Particular emphasis is placed on the neural mechanisms involved. Prerequisites: Psych 1; eight semester hours of physics, chemistry or biology.

376. (Psych 382) Biopsychology (3) spring
Human and animal behavior from a genetic, evolutionary, and physiological perspective. Techniques for assessing the role of genes, environment, and evolution. Prerequisite: Psych 1 or Biol 21 or Anth 12.

Mini-Courses at The Wetlands Institute

The following courses, Biol 381 through 386, are one-credit mini-courses offered only at The Wetlands Institute. Approval of the department chairperson is required for all of the courses.

381. Phytoplankton of Estuaries (1)
Survey of the phytoplankton found in New Jersey salt marsh waters. Laboratory work in collecting and identifying organisms, and lectures on the morphology, biochemistry, and physiology of the organisms.

382. Plant Succession in Salt Marshes (1)
Survey of the large plants found in salt marshes and in other marine environments. Field work collecting and identifying the plants; lectures on their biochemistry, physiology and morphology.

383. Marine Invertebrate Zoology (1)
The dominant taxa of the marine environment; the wetlands fauna, including taxonomy, life history, adaptations, and interrelationships of these organisms. Consideration of the environmental parameters determining the distribution and abundance of marine fauna.

384. Estuarine Zooplankton (1)
Study of temporary and permanent members of the animal plankton of shallow water. Sampling techniques, life histories, and morphology of major forms. Lectures, laboratories, and field trips.

385. Marine Habitats (1)
Ecological field course in the planktonic, benthic, marsh, and sand beach habitat of the coast of southern New Jersey. Emphasis on the major biotic associations in each area and their relationship to physical and chemical influences in the environment. Competition and predation in each habitat.

386. Marine Fish Taxonomy (1)
Lectures in anatomy and physiology of marine fishes. Laboratory will emphasize collecting procedures and identification of specimens.

Graduate Study in Biology

The biology department accepts a limited number of students who are interested in graduate study towards the doctor of philosophy degree. Candidates for the master of science degree are also accepted but emphasis is on the former degree. The department averages about twenty full-time graduate students in residence each year.

The training program initially emphasizes breadth in biology followed by concentration in a special field of interest. Because of the small number of department staff members and the restricted number of graduate students, staff and students work together closely, especially during the years of student specialization.

Departmental research thrusts are focused in two general areas: environmental, and cellular/molecular biology. Specializations in environmental research include: functional morphology of feeding in reptiles; organismal energetics; aquatic toxicology, including fate and effect of atmospheric pollutants; marine and fresh-

water zooplankton ecology; dynamics of aquatic food chains; predator-prey interactions; sociobiology of coral reef and freshwater fishes. Active research programs in cellular/molecular biology include: behavior of motile cells; chemostat studies of microbial evolution; fish viruses and poikilotherm cell culture; biochemistry and genetics of microorganisms oriented to biotechnology; non-vascular and vascular plant cytochemistry; comparative ultrastructure and physiology of invertebrate mechanoreceptors and chemoreceptors.

Each entering student is initially guided by his or her own faculty committee. A separate M.S. or Ph.D. committee later directs progress towards the advanced degree and tailors the program to fit special needs and interests of the student.

The prerequisite for graduate work in biology is undergraduate training in biology, chemistry, physics, and mathematics approximately equivalent to that taken by biology majors at Lehigh University. Minor deficiencies in these areas may be completed during the first year of graduate study—usually, however, without graduate credit. Candidates for admission to graduate study in biology must take the Graduate Record Examination Advanced Aptitude test in biology as well as the GRE Verbal and Mathematical aptitude tests. Failure to include results of these examinations with the application for admission can seriously delay or prevent action on the application.

Graduate Courses in Biology

402. Comparative Animal Physiology (3)
Lectures and seminars on selected areas in the comparative physiology of animals. Introduction to the current literature of subjects studied. These include mechanisms of osmotic control, temperature effects, nerve and muscle physiology and others. Prerequisite: Biol 320 or 322.

405. Special Topics in Biology (1-3)
Research, conferences, and reports on selected topics not covered in the general graduate offerings. May be taken more than once for credit.

406. Biological Seminar (1)
An advanced seminar in current developments including departmental research. Required for candidates for graduate degrees. May be taken more than once for credit.

407. Biological Research (3)
Investigations in any phase of the biological sciences according to the student's preparation and interests.

408. Biological Research (3)
Continuation of Biol 407.

409. Advanced Morphology (3)
A laboratory course in special phases of morphology, such as comparative osteology, comparative morphology, or embryology of the vertebrates, etc., to meet the individual interest of the student.

411. Advances in Water Pollution Biology (3)
Discussion of major water pollution problems will be linked to laboratory experiments and field investigations in local streams and lakes. An independent research project is required. Two lectures and one laboratory or field trip. Not open to students who have received credit for Biol 311.

414. Advanced Ecology (3)
Seminars, conferences and directed field work with emphasis on theoretical models and their application to real biological systems. May be taken more than once for credit. Prerequisite: consent of the department chairperson.

415. Cytochemistry (3)
A study of morphological and biochemical events during cell growth and differentiation including lectures, laboratories, and student reports on current literature. Special emphasis is placed on developmental patterns and laboratory procedures of the cytochemist. Prerequisite: consent of the department chairperson.

416. Immunology (3)
Consideration of antigen-antibody systems from theoretical and practical aspects. Lectures and reports on the structure and origins of antigens and antibodies and the mechanisms of agglutination, precipitation, complement fixation, anaphylaxis, etc. Laboratory work on preparation, standardization, and assay of antigens and antibodies. Prerequisite: Biol 353, or Chem 371.

417. Marine Ecology (3)
Advanced study of the physical and chemical influences in the marine environment on organisms and their interrelations. Ecological theory pertaining to population dynamics and energy flow. Prerequisite: consent of the department chairperson.

418. Biological Oceanography (3)
Surveys of marine plant and animal plankton; nekton and benthos. Composition of various groups, productivity, interrelationships of plants and animals and the role of microorganisms in the sea. Prerequisite: consent of the department chairperson.

419. Analysis of Reproduction and Mating Systems (3)
Study of reproduction and sexuality in plants and animals with emphasis on current hypotheses as reported in the literature. Topics include hermaphroditism, neoteny, larval forms, parental investment, complex life cycles, population structure. Lecture sections may be in common with Biol 319. Readings from primary source material and review articles. One review paper and one research proposal are required, and together with readings, forms the basis for discussion sections and examinations. Prerequisite: consent of the department chairperson. Not open to students who have taken Biol 319.

420. Cellular Mechanisms (3)
Discussions focused on the molecular mechanisms underlying the biology of cellular and microbial systems. Specific topics emphasize the interests of the participants, but might include: microbial behavior; the evolution and genetics of subcellular specialization; active transport; nucleic acid biochemistry; chromosome replication; cell surface specificities; the functioning of organelles; intracellular and intercellular coordination; viral specificity and reproduction.

425. Biological Electron Microscopy (3)
Uses of the transmission and scanning electron microscopes in biology. Lectures and laboratory work in the preparation of biological specimens for study with both kinds of electron microscopes and independent work at both kinds of microscopes. Study of current information on cell ultrastructure.

429. Advances in Herpetology (3)
Lectures and readings from the primary literature on current research in amphibian and reptilian biology. Two lectures, one discussion session and one laboratory field trip. In addition, a week-long field trip during spring vacation is required. Not open to students who have received credit for Biol 329.

433. Growth and Development in Plants (3)
A comparative study of embryo and cellular development in the plant kingdom including the algae, bryophytes and tracheophytes. Emphasis is placed on morphology,

physiology and the role of macromolecular substances during growth and differentiation. Literature search, experimental work and oral reports. Two lectures and one laboratory.

437. Advanced Sociobiology (3)
Critical evaluation of the theoretical foundation in sociobiology. Emphasis placed on kinship, altruism, mate choice, parental investment, parent-offspring conflict, etc. Lectures and seminars. Not open to students who have taken Biol 337.

441. Marine Botany (3)
A study of the morphological, physiological, biochemical and ecological features of those plants found primarily in the salt water environment. Emphasis is placed on the evolutionary and ecological significance of the phytoplankton, benthic algae and rooted aquatic plant divisions associated in and near the oceans. The economic importance of these plants is considered. Laboratory work, field work and library searches and reports.

442. Marine Zooplankton (3)
A comprehensive study of neritic and oceanic plankton. Studies on the life history, morphology and distribution of both holoplanktonic and meroplanktonic animals. Prerequisite: consent of the department chairperson.

443. Ichthyology (3)
Lectures and laboratory on the anatomy, physiology, behavior and taxonomy of marine and fresh-water fishes.

444. (Geol 444) Multivariate Analysis (3)
The strategy of the application of multivariate analysis techniques to problems in geology and biology. Analysis of large data matrices by factor analysis, cluster analysis, discriminant function analysis, ordination,and related techniques. Examples from both geology and biology. Prerequisites: Geol 10 and Geol 321 or approved equivalents.

445. Nucleic Acids and Nucleic Acid Complexes (3)
Structure of DNA, replicative intermediates and chromosomes; messenger RNA, transfer RNA, ribosomal RNA, and ribosomes. Readings, lectures, and recitations. Prerequisite: consent of the department chairperson.

447. (Chem 447) Experimental Molecular Biology (3)
A survey of current research in molecular biology.

480. (Geol 480) Marine Science Seminar (1)
An advanced interdisciplinary seminar on various problems of marine sciences, with visiting speakers and student presentations. May be substituted for Biol 406.

Chemical Engineering

Professors. Leonard A. Wenzel, Ph.D., *chairman.*Marvin Charles, Ph.D.; John C. Chen, Ph.D., Anderson Professor; Mohamed S. El-Aasser, Ph.D.; Curtis W. Clump, Ph.D.; Arthur E. Humphrey, Ph.D.; William L. Luyben, Ph.D.; William E. Schiesser, Ph.D., McCann Professor; Leslie H. Sperling, Ph.D.; Fred P. Stein, Ph.D.
Associate professors. Andrew Klein, Ph.D.; Hugo S. Caram, Ph.D.
Assistant professors. Fikret Kargi, Ph.D.; Janice A. Phillips, Ph.D.; Cesar A. Silebi, Ph.D.
Adjunct professors. Jacob M. Geist, Ph.D.; M. Orhan Tarhan, Dipl. Ing.
Adjunct associate professors. Montford S. Benson, Ph.D.; Ravindra S. Upadhye, Ph.D.
Visiting professor. Alan S. Michaels, Sc.D.
Research associates. Nobuo Bessho, Victoria Dimonie, Zhao-XI Liang, Yong-zai Lu.

Chemical engineers serve a wide variety of technical and managerial functions within the chemical processing industry. For maximum career-length effectiveness they need a sound background in the fundamental sciences of chemistry and physics, a working capability with both analytical and numerical mathematics and the computers through which they are often used, and a broad education in humanities, social sciences, and managerial techniques.

These bases are applied in a sequence of courses called chemical engineering in which logic and mathematical manipulations are applied to simulated chemical processing problems.

With the resulting habits of precise thought coupled to a broad base in scientific and general education, Lehigh graduates have been effective throughout industry and in advanced professional education. No effort is made in orientation toward any specific industry, but adaptation is rapid and the fundamental understanding forms the base for an expanding career.

The program also is designed to prepare a student for graduate study in chemical engineering or in peripheral fields. Further study at the graduate level leading to advanced degrees is highly desirable if an individual wishes to participate in the technical development of the field. The increasing complexity of modern manufacturing methods requires superior education for men and women working in research, development, and the design fields or for teaching.

Physical facilities. The department is located in Whitaker Laboratory. In this building some 40,000 square feet of space is available for departmental research, teaching, and office needs.

The building includes specially designed facilities for analog and digital computation, calibration standards, minicomputers for process dynamics study, specially protected rooms for reaction kinetics and thermodynamics research and for high-pressure research, special equipment for biochemical engineering, and a wide range of general laboratory equipment for undergraduate study of the behavior of typical chemical processing units.

More complete descriptions of research equipment can be found in Section IV, graduate programs in chemical engineering.

Career Opportunities

Chemical engineers play important roles in all activities bearing on the chemical process industry. These include the functions of research, development, design, plant construction, plant operation and management, corporate planning, technical sales, and market analysis.

The industries that produce chemical and/or certain physical changes in fluids including petroleum and petrochemicals, rubbers and polymers, pharmaceuticals, metals, industrial and fine chemicals, foods, and industrial gases have found chemical engineers to be vital to their success. Chemical engineers are also important participants in pollution abatement, energy resources, and national defense programs.

Special Programs and Opportunities

The department operates a cooperative program that is optional for specially selected students who have completed their sophomore year. This program affords early exposure to industry and an opportunity to integrate academic background with significant periods of engineering practice. Students in this program are able to earn most of their college expenses.

Opportunities for undergraduate involvement in research projects, special design projects, and programs of independent study are many, but are usually arranged specifically between a student and a professor. The higher degree of curricular flexibility encourages the

student to emphasize an area of special interest in the selection of electives. In some cases this may lead to a minor in addition to the chemical engineering major.

Requirements of the Major

freshman year: see Recommended Freshman Year, page 46.

sophomore year, first semester (18 credit hours)

ChE 43	Introduction to Chemical Engineering (4)
Chem 31	Equilibrium (3)
Math 23	Calculus and Analytic Geometry (4)
Eco 1	Economics (4)
	elective (3)

sophomore year, second semester (15-18 credit hours)

Math 205	Linear Algebra (3)
ChE 44	Chemical Process Analysis I (4)
Chem 187	Physical Chemistry (3)
Phys 21	Physics (4)
Phys 22	Physics Laboratory (1)
	electives (0-3)

junior year, first semester (16 credit hours)

ChE 141	Chemical Process Analysis II (4)
Chem 51	Organic Chemistry (3)
Chem 53	Organic Chemistry Laboratory (1)
Chem 191	Physical Chemistry (3)
Chem 192	Physical Chemistry Laboratory (2)
	elective (3)

junior year, second semester (17 credit hours)

ChE 142	Chemical Process Analysis III (4)
Chem 52	Organic Chemistry (3)
ChE 210	Chemical Engineering Thermodynamics (4)
ChE 200	Chemical Engineering Laboratory I (3)
	elective (3)

junior year, summer

ChE 100	Industrial Employment (0)

senior year, first semester (17 credit hours)

ChE 211	Chemical Reactor Design (3)
ChE 233	Process/Plant Design (3)
ChE 201	Chemical Engineering Laboratory II (2)
	electives (9)

senior year, second semester (15-18 credit hours)

	electives (15-18)

In regard to electives, where there is a range of credit indicated the student is expected to take the larger number of course. However, by petition, it is possible for the student to take the minimum number of credit hours indicated.

Electives are of four types:
General Studies (see page 46): 12 credit hours
approved engineering fundamentals (see list available in the department office) to include Mech 1 or Mech 103: 12 credit hours
approved chemistry (see list available in department office): 3 credit hours
free electives: six to twelve credit hours
total elective credit hours: 33 to 39

Undergraduate Courses

43. Introduction to Chemical Engineering (4) fall
Material and energy balances with and without chemical reaction. Applications in chemical process calculations and in design of separations cascades, especially distillation. Plant trips and special lectures introductory to the profession.

44. Chemical Process Analysis I (4) spring
The mechanisms of diffusional processes and applications to chemical processing. Heat, mass, and momentum transfer. Laminar and turbulent flow and applications to process flow situations. Three recitations and one laboratory/calculation period per week.

60. Unit Operations Survey (3) fall
The theory of heat, mass and momentum transport. Laminar and turbulent flow of real fluids. Heat transfer by conduction, convection, and radiation. Application to a wide range of operations in the chemical and metallurgical process industries.

100. Summer Employment
During the summer (preferably following the junior year) candidates for the degree of bachelor of science in chemical engineering are required to obtain industrial experience through employment for at least eight weeks in a plant, laboratory or engineering office and submit a report thereon.

141. Chemical Process Analysis II (4) fall
The application of transfer fundamentals and conservation laws to the analysis and design of chemical processing units. Examples for detailed analysis will include operations where heat, mass, and momentum are in transit. Where needed, processing technology will be discussed. Prerequisites: ChE 43 and ChE 44.

142. Chemical Process Analysis III (4) spring
Analysis of time-variant and multidimensional process situations. The use of computer-based techniques for the solution of the resulting mathematical models. Introduction to process control. Prerequisites: ChE 141 and Math 205.

179. Professional Development (1) fall
Elements of professional growth, registration, ethics, and the responsibilities of engineers both as employees and as independent practitioners. Proprietary information and its handling. Patents and their importance. Discussions with the staff and with visiting lecturers. A few plant trips. Prerequisite: junior standing.

185. Undergraduate Research I (3)
Independent study of a problem involving laboratory investigation, design, or theoretical studies under the guidance of a senior faculty member.

186. Undergraduate Research II (3)
A continuation of the project begun under ChE 185. Prerequisites: ChE 185 and consent of the department chairperson.

For Advanced Undergraduates and Graduate Students

200. Chemical Engineering Laboratory I (3) spring
The laboratory study of chemical engineering unit operations and the reporting of technical results. One three-hour laboratory and one lecture period per week. Independent study and both group and individual reporting. Prerequisite: ChE 141.

201. Chemical Engineering Laboratory II (2) fall
Laboratory experience with more complex chemical processing situations including processes involving chemical reactions and those controlled automatically. Prerequisites: ChE 141 and ChE 142 previously or concurrently.

210. Chemical Engineering Thermodynamics (4) spring
Energy relations and their application to chemical engineering. Consideration of flow and nonflow processes. Evaluation of the effects of temperature and pressure on the thermodynamic properties of fluids. Heat

effects accompanying phase changes and chemical reactions. Determination of chemical and physical equilibrium. Prerequisite: Chem 187 or equivalent.

211. Chemical Reactor Design (3) fall
The application of chemical kinetics to the design and operation of chemical reactors. Plug flow and continuous stirred tank reactors. Homogeneous and heterogeneous reaction kinetics. Design of isothermal and adiabatic reactors. Prerequisites: ChE 141, ChE 210 or equivalent.

233. Process/Plant Design (3) fall
Economic principles involved in the selection of process alternates and determination of process operating costs. Preliminary design of chemical plants including optimization of process configuration, market limitations on plant planning, environmental and regulatory restrictions. Prerequisites: ChE 141 and ChE 210.

301. Process Design (3) spring
Study of the strategy of chemical process design with emphasis on optimum order of steps, flow diagrams, energy balances, recycle ratios and their effect on the economics of the operation. Survey of methods for ordering equations. Discussion of process optimization for nonlinear systems. Effects of uncertainty in process design.

312. (Chem 312, Met 312) Fundamentals of Corrosion (3) fall
Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization, and passivity. Nonelectrochemical corrosion including mechanisms, theories, and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisite: Met 210, Chem 187, or equivalent. Leidheiser or Smyth

320. Waste Water Control (3) fall
The physical processes of importance in the design of industrial waste-water treatment facilities. Topics will include sedimentation and filtration processes as well as advanced methods such as adsorption, ion exchange, osmosis, foaming, freezing, and hydrate formation.

321. Fundamentals of Air Pollution (3) spring
Introduction to the problems of air pollution including such topics as: sources and dispersion of pollutants; sampling and analysis; technology of economics and control processes; legislation and standards. Prerequisite: senior standing in the College of Engineering and Physical Sciences.

331. Distillation (3)
Design and operating strategies and techniques. Computer solutions for simple and complex multicomponent distillation columns. Shortcut design methods. Tray hydraulics and constraints. Petroleum fractionators and azeotropic and extractive distillation.

341. Biotechnology I: Industrial Microbiology and Biochemistry (3)
The microbiology of industrially important microorganisms and of waste-water treatment processes. Microbial and enzyme kinetics. Selection, screening, development, and maintenance of industrial microorganisms. Formulation of industrial fermentation media. Biochemical and physico-chemical principles of recovery and purification processes. Industrial aspects of recombinant DNA technology.

342. Biotechnology II: Engineering Principles (3)
Engineering principles of bio-processing. Fundamentals of heat and mass transfer, mixing, and biocatalysis applied to the design of: fermentors; other bioreactors; recovery and purification processes. Sources of raw materials for, and formulation of media for industrial bioconversions. Principles of sterilization and design for aseptic operation. Design of biological waste-water treatment processes. Economics of bio-processing. Special topics (e.g., mixed cultures, cell-plant culture) as time permits.

350. Special Topics (1-3)
A study of areas in chemical engineering not covered in courses presently listed in the catalog. May be repeated for credit if different material is presented.

360. (ME 360) Nuclear Reactor Engineering (3) fall-spring
A consideration of the engineering problems in nuclear reactor design and operation. Topics include reactor fuels and materials, thermal aspects, instrumentation and control problems, radiation protection and shielding, fuel processing, and reactor design. Prerequisite: senior standing in the College of Engineering and Physical Sciences.

380. Design Projects (1-6) fall-spring
Design project work as a member of a team preferably including students from different disciplines. The project attacks a problem which, when possible, involves one of the local communities or industries. Specific projects are normally guided by faculty from several departments with consultants from off the campus. The course may be repeated for credit.

386. Process Control (3) fall
Laplace transformation and transfer functions, frequency response, feedback, and feedforward control. Open-loop and closed-loop stability analysis using root locus and Nyquist techniques, design of feedback controllers with time and frequency domain specifications. Experimental process identification, introduction to sampled-data control theory. Prerequisite: ChE 286 or equivalent.

388. (Chem 388) Polymer Synthesis and Characterization (1-3) fall
Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties. Prerequisite: Chem 51, 187 or 191.

392. (Chem 392) Polymer Science (3) spring
Introduction to concepts of polymer science. Kinetics and mechanism of polymerization, synthesis and processing of polymers, characterization. Relationship of molecular conformation, structure and morphology to physical and mechanical properties. Prerequisite: Chem 187 or equivalent.

393. (Chem 393, Met 343) Physical Polymer Science (3) fall
Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline, and paracrystalline states (including viscoelastic and relaxation behavior) for single and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology, and behavior. Prerequisite: one year of physical chemistry.

394. (Chem 394) Organic Polymer Science (3) spring
Organic chemistry of synthetic high polymers. Functionality and reactivity of monomers and polymers. Theory of stepgrowth and chaingrowth polymerization in homogeneous and heterogeneous media. Polymerization by addition, elimination, substitution and coupling reactions. Ionic fee-radical and coordinate catalysis. Prerequisites: one year of physical chemistry and one year of organic chemistry.

Graduate Programs

The department of chemical engineering offers graduate programs leading to the master of science, master of engineering, and doctor of philosophy degrees. The programs are all custom tailored for individual student needs and professional goals. This is made possible by a diversity of faculty interests that is broadened and reinforced by cooperation between the department and several research centers on the campus.

A free flow of personnel and ideas between the centers and academic departments insures that the student will have the widest choice of research activities. The student is also exposed to a wide range of ideas and information through courses, seminars, etc., to which both faculty and center personnel contribute. In addition, strong relationships with industry are maintained by the department and the research centers, some of which operate industrially sponsored liaison programs whereby fundamental nonproprietary research is performed in areas of specific interest to participating sponsors.

Some of the centers currently operating are: Center for Health Sciences, Center for Information and Computer Science, Center for Marine and Environmental Studies, Center for Surface and Coatings Research, Biotechnology Research Center, Center for the Application of Mathematics, Materials Research Center, and Center for Social Research.

While the department has interacted with almost all of these centers, it has had unusually strong and continuing liaisons with the Materials Research Center, the Center for Surface and Coatings Research, and the Biotechnology Research Center.

In addition to interacting with the centers, the department originates and encourages programs that range from those that are classically chemical engineering to those that are distinctly interdisciplinary. The department offers active and growing programs in: emulsion polymerization and latex technology; bulk polymer systems; process control; process improvement studies; rheology; computer applications; environmental engineering; thermodynamics; kinetics and catalysis, enzyme technology; and biochemical engineering.

Wherever possible, attempts are made to gain the cooperation and participation of other academic departments and research centers in building these programs.

Career Opportunities

Master of science and doctor of philosophy graduates in the chemical engineering area are sought by industry for activities in the more technical aspects of their operations, especially design, process and product development, and research. Many of these graduates also find opportunities in research or project work in government agencies and in university teaching and research.

Physical Facilities

The department is well equipped for research in polymer science and engineering, catalysis and reaction kinetics, thermodynamic property studies, fluid dynamics, heat and mass transfer, process dynamics and control, and enzyme engineering and biochemical engineering.

Major facilities include a PDP 11/40 and a PDP 11/34 real time computers, differential scanning calorimeter, Philips transmission electron microscope plus scanning attachment, RCA transmission electron microscope, ETEC scanning electron microscope, gel permeation chromatography, intrinsic viscosity measurement, Weissenberg rheogoniometer, continuous particle electrophoresis unit, surface titration unit, preparative and analytical ultracentrifuges, liquid chromatography unit for colloid particle size analysis, polymerization reactor systems, vapor-liquid equilibria cell, PVT unit, Joule-Thomson coefficient unit, fluid-bed enzyme catalysis pilot plant, fermentation equipment of diverse sizes and degrees of automation, hot wire anemometer, and high-pressure catalytic reaction unit.

Special Programs

Master of engineering design option. For those interested in design, the department offers the master of engineering design option. In this program, the student works on a design project proposed by the process design group of a cooperating industry. Direction of the design project is shared by the cooperating industry and a member of the faculty. Students desiring to enroll in this program should indicate that fact at the time they apply for admission.

Chemical metallurgy program. This program is jointly administered by the departments of chemical engineering and metallurgical engineering and should be particularly appealing to students interested in process metallurgy.

The student's program is arranged to supplement the bachelor of science program so that the technology of the extractive metallurgy industry is understood and the tools needed to work effectively in it are acquired. The master of science thesis is chosen from problems relevant to the metals processing industry.

Polymer science and engineering. The polymers activity includes work done in the Materials Research Center, the Center for Surface and Coatings Research, the Center for the Application of Mathematics, the department of chemistry, and the department of chemical engineering.

About a dozen faculty members from these organizations or areas have major interests in polymers and cooperate on a wide range of research projects. For students with deep interest in the area, degree programs are available leading to the master of science and doctor of philosophy degrees in polymer science and engineering.

Research activities in which chemical engineering students and faculty are involved include a major study of impregnation of bridge decks with polymers to increase surface life; studies of the mechanism of continuous emulsion polymerization; work on polymer blends, especially interpenetrating networks, and the application of these materials to sound-deadening; rheology of viscoelastic materials; crystallization behavior from polymer melts and solutions; polymer film characteristics and the tailoring of these properties for selective transfer rates; latex film drying rates; coatings and the hiding capabilities of micropores; and the preparation of polymeric materials from agricultural raw materials.

Master of engineering degree. Students may earn the master of engineering degree in chemical engineering upon completion of a course of study and an engineering project meeting all the requirements of the master of science degree. The master of engineering student, however, elects courses closer to engineering practice, and carries out a project of more practical engineering flavor than that of the M.S. candidate. In some cases the project of the master of engineering student will be done in close collaboration with local industry, as noted above.

Major Requirements

The requirements for the master of science degree are listed in the section on The Graduate School. All candidates for the M.S. degree are required to complete a master of science research report for which three to six hours of graduate credit are earned. Course selection is done individually, for each student, although ChE 400 and ChE 415 are considered as core courses.

The requirements for the doctor of philosophy degree also are listed in the section on The Graduate School. In addition to an approved course and thesis program, the Ph.D. student is expected to pass a qualification examination given within the first year of doctoral-level study and to pass a general examination based on a research proposal or independent problem presented by the student.

Advanced Courses in Chemical Engineering

400. Chemical Engineering Thermodynamics I (3) fall
Applications of thermodynamics in chemical engineering. Topics include energy and entropy, heat effects accompanying solution, flow of compressible fluids, refrigeration including solution cycles, vaporization and condensation processes, and chemical equilibria. Prerequisite: an introductory course in thermodynamics. Stein, Wenzel

401. Chemical Engineering Thermodynamics II (3)
A detailed study of the uses of thermodynamics in predicting phase equilibria in solid, liquid, and gaseous systems. Fugacites of gas mixtures, liquid mixtures, and solids. Solution theories; uses of equations of state; high-pressure equilibria. Stein, Wenzel spring

410. Chemical Engineering Kinetics (3)
The application of chemical kinetics to the engineering design and operation of reactors. Non-isothermal and adiabatic reactions. Homogeneous and heterogeneous catalysis. Residence time distribution in reactors. Prerequisite: ChE 302. Klein

413. Heterogeneous Catalysis (3)
Surface area, pore structure and pore-size distribution of catalysis. Influence of pore-diffusion on catalytic reactions and the design of catalytic reactors. Chemical adsorption and physical adsorption. Chemistry, energetics and kinetics of adsorption, desorption, and surface reaction. Electronic structure and catalysis; atomic orbital and bondstructure models. Mechanisms of catalytic reactions of industrial importance. Selection and classification of catalysis.

415. Transport Processes (3)
A combined study of the fundamentals of momentum transport, energy transport and mass transport and the analogies between them. Evaluation of transport coefficients for single and multicomponent systems. Analysis of transport phenomena through the equations of continuity, motion, and energy. Caram, Silebi

421. Heat Transfer (3)
Analysis of steady and unsteady state transfer. Convection, conduction, and radiation. Vaporization and condensation. Heat transfer in high velocity flow in rarified gases. Applications. Clump, Chen

427. (ME 427) Multiphase Heat Transfer (3) spring, 1983, approximately every third semester
Heat transfer and fluid dynamics of multiphase systems. Subcooled, nucleate, and film boiling; bubble nucleation; dynamics of bubble growth and collapse; vapor-liquid cocurrent flow regimes; two-phase pressure drop and momentum exchange, low instabilities; convective-flow boiling; simultaneous heat and mass transfer. Prerequisite: ChE 421 or ME 321, or courses in the area of transport phenomena. Chen

428. Rheology (3)
An intensive study of momentum transfer in elastic viscous liquids. Rheological behavior of solution and bulk phase polymers with emphasis on the effect of molecular weight, molecular weight distribution and branching. Derivation of constitutive equations based on both molecular theories and continuum mechanics principles. Application of the momentum equation and selected constitutive equations to geometries associated with viscometric flows. Silebi

430. Mass Transfer (3)
Theory and developments of the basic diffusion and mass transfer equations and transfer coefficients including simultaneous heat and mass transfer, chemical reaction, and dispersion effects. Applications to various industrially important operations including continuous contact mass transfer, absorption, humidification, etc. Brief coverage of equilibrium stage operations as applied to absorption and to binary and multicomponent distillation. Clump, Silebi

440. Process Design (3)
Synthesis of flow sheets for various processes, investigation of contributions to overall economy of various alternatives. Evaluation of profitability of alternatives.

441. Advanced Process Control (3)
Sampled-data control theory with applications in digital computer control systems. Nonlinear methods of dynamic analysis. Optimal control via calculus of variations and the maximum principles. Luyben

445. Enzyme Engineering (3)
Existing and potential industrial applications of enzymes. Enzyme characteristics including nomenclature, physical properties, kinetics and assay methods with emphasis on practical application at commercial scale. Practical commercial methods of enzyme production and purification. Design of industrial-scale reactors employing soluble enzymes. Immobilized enzymes; enzyme cofactors. Charles

450. Special Topics (2-12)
An intensive study of some field of chemical engineering not covered in the more general courses. Credit above three hours is granted only when different material is covered.

451. Problems in Research (1)
Study and discussion of optimal planning of experiments and analysis of experimental data. Discussion of more common and more difficult techniques in the execution of chemical engineering research.

455. Seminar (1-3)
Critical discussion of recent advances in chemical engineering. Credit above one hour is granted only when different material is covered.

460. Chemical Engineering Project (1-6)
An intensive study of one or more areas of chemical engineering, with emphasis on engineering design and applications. A written report is required. May be repeated for credit.

461. Mathematical Methods in Chemical Engineering I (3)
Application of ordinary and partial differential equations to the solution of chemical engineering problems with emphasis on chemical reactions and transport processes as they occur in industrial chemical processing. Applications of solution in series, separation of variables, and integral transforms. Prerequisite: Math 322. Caram

464. Numerical Methods in Engineering (3) fall
Applied computer-oriented mathematics including linear difference operators, interpolation polynomials, numerical quadrature based on the Newton Cotes open and closed formulas, matrices and linear algebra with emphasis on the solution of large sparse systems, algorithms for nonlinear algebraic and transcendental systems. Computer solution of problems selected from a number of scientific and engineering disciplines. Schiesser

465. Numerical Methods in Engineering (3) spring
A continuation of ChE 464 with emphasis on the numerical integration of ordinary and partial differential equations. Topics include: single step and multistep algorithms for initial value problems in ordinary differential equations, error monitoring and control, stability and the integration of stiff systems, geometric classification of partial differential equations, explicit and implicit finite difference algorithms, convergence, consistency and stability. Schiesser

470. Cryogenic Engineering (3)
Liquefaction and separation of gases, physical and chemical principles. Low-temperature themometry. Insulation. Properties of fluids and of structural materials. The behavior of helium. Ultra-low temperature phenomena and theories. Wenzel

471. Low-Temperature Processes (3)
The problems and design of plants operating in the cryogenic temperature range. Refrigeration demands. Distillation and heat exchange at low temperatures. Analysis of processes for thermodynamic and operating efficiency. Problems of safety, non-steady state behavior and control. Wenzel

480. Research (3-4)
Investigation of a problem in chemical engineering.

481. Research (3-4)
Continuation of ChE 480.

482. (Chem 482, Met 482) Engineering Behavior of Polymers (3)
A treatment of the mechanical behavior of polymers. Characterization of experimentally observed visocelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture and aging on mechanical behavior. Robinson

483. (Chem 483) Emulsion Polymers (3)
Examination of fundamental concepts important in the manufacture, characterization, and application of polymer latexes. Topics to be covered will include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation, and various application problems. El-Aasser, Vanderhoff, Klein

484. (Chem 484) Crystalline Polymers (3)
An in-depth treatment of the morphology and behavior of both polymer single crystals and bulk crystallized systems. Emphasis is placed on the relationship between basic crystal physics, thermal and annealing history, orientation and resulting properties. A detailed discussion of the thermodynamics and kinetics of transition phenomena and a brief treatment of hydrodynamic properties and their relationship to crystallization and processing properties. Prerequisite: ChE 392 or ChE 393 or equivalent.

485. (Chem 485) Polymers Blends and Composites (3)
An intensive study of the synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated concrete, and fiber and particulate reinforced polymers are emphasized. Prerequisite: any introductory course in polymers. Manson, Sperling

486. Polymer Processing (3)
Application of fundamental principles of mechanics, fluid dynamics and heat transfer to the analysis of a wide variety of polymer flow processes. A brief survey of the rheological behavior of polymers is also included. Topics include pressurization, pumping, die forming, calendering, coating, molding, fiber spinning and elastic phenomena. Prerequisite: ChE 392 or equivalent. Silebi

492. (Chem 492) Topics in Polymer Science (3)
Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered. Prerequisite: Chem 392 or equivalent.

Chemistry

Professors. G. Doyle Daves, Ph.D., *chairperson;* Robert S. Sprague, Ph.D., *assistant chairperson;* Jack A. Alhadeff, Ph.D.; Ned D. Heindel, Ph.D., Howard S. Bunn Professor of Chemistry and director, Center for Health Sciences; Kamil Klier, Ph.D., University Professor of Chemistry; Charles S. Kraihanzel, Ph.D.; Henry Leidheiser, Jr., Ph.D., director, Center for Surface and Coatings Research; Roland W. Lovejoy, Ph.D.; John A. Manson, Ph.D., director of the polymer laboratory, Materials Research Center; Joseph R. Merkel, Ph.D.; William E. Ohnesorge, Ph.D.; Keith J. Schray, Ph.D.; Gary W. Simmons, Ph.D.; Donald M. Smyth, Ph.D., director, Materials Research Center; James E. Sturm, Ph.D.; John W. Vanderhoff, Ph.D., director, Emulsion Polymers Institute, and associate director, Center for Surface and Coatings Research; Thomas E. Young, Ph.D.
Associate professors. Fortunato J. Micale, Ph.D.; Daniel Zeroka, Ph.D.
Assistant professor. Yuji Hazeyama, Ph.D. (on leave 1982-83)
Instructor. Natalie Foster, D.A., Ph.D.
Adjunct and active emeritus professors. Eugene M. Allen, Ph.D.; Robert Eischens, Ph.D.; Frederick M. Fowkes, Ph.D.; John W. LeMaistre, Ph.D.; Courtland N. Robinson, Ph.D.; Albert C. Zettlemoyer, Ph.D.

Chemistry is a versatile subject area and the pursuit of a career in chemistry can be a most intellectually satisfying experience. No other basic science touches and shapes as many aspects of modern society as does chemistry. From soft contact lenses and synthetic blood to longer-lasting paint and alternative fuel sources, the study of chemistry has provided the solutions to complex problems and has improved the quality of all phases of human life.

That chemists at all levels of education find a market for their skills and knowledge in every employment area is further demonstration of the breadth of the science of chemistry. Chemists provide the technical backbone for the manufacturing industries (pharmaceuticals, plastics, paper, electronics, agriculture), for service industries (clinical and forensic laboratories, academe, environmental protection, information science) and for governmental positions in regulatory agencies and in science policy analysis. Many chemists are also employed in nontraditional areas—patent law, insurance underwriting, sales, product management, journalism, and even banking.

The alluring challenge of chemistry inspires many bachelor-degree holders to study for an advanced degree so that undergraduate preparation in chemistry enables future study within the discipline of chemistry and in other areas as well. Chemistry or biochemistry is the strongest preparation for graduate studies or professional school in the health-related disciplines (medicine, pharmacology, biochemistry) as well as for other science programs (materials science, polymers, environmental studies, mineralogy).

The study of chemistry opens doors to satisfying careers, to a stimulating view of the world, and to a professional life in which one's natural tendency to ask "why" can lead to personally rewarding endeavors.

The undergraduate curriculum in chemistry contains many of the prerequisites for biology, geological sciences, metallurgy, physics, and chemical engineering, so that students can normally transfer with no loss of credits at least through the sophomore year.

Chemistry students have the opportunity to design

their undergraduate curricula for specialization in a variety of fields:

health-related chemistry (including premedical students)
suggested biology electives: 21, 22, 28, 320, 353.
suggested chemistry electives: 336, 371, 372, 377, 378.
suggested physics electives: 367, 368.

materials chemistry (polymers, solid state, surfaces)
suggested physics electives: 31, 363.
suggested chemistry electives: 312, 388, 392, 393, 394, 395, 396.

environmental chemistry
suggested biology electives: 21, 22, 135, 306, 309.
suggested chemical engineering electives: 320, 321.
suggested chemistry electives: 303, 310, 334, 395.
suggested civil engineering electives: 371, 374.

geochemistry
suggested geology electives: 333, 334, 336, 352, 372.
suggested chemistry electives: 303, 396.

chemistry management
suggested accounting electives: 51, 52, 324.
suggested law elective: 201.
suggested management electives: 270, 302, 321 or 333.
suggested economics electives: 105, 119, 229.
suggested marketing electives: 211, 312.
suggested finance electives: 225, 326.

Any of the above courses can be used to waive required graduate courses for the M.B.A. at Lehigh.

The Five-Year Program

Five-year programs are available for students to receive bachelor of science or bachelor of arts degrees and the master of science degree in several fields of chemistry (inorganic, organic, analytical, physical chemistry, polymers or biochemsitry).

B.A. and B.S. Degrees in Chemistry

Lehigh University offers a bachelor of arts degree in chemistry from the College of Arts and Science and a bachelor of science degree in chemistry from the College of Engineering and Physical Sciences. The required courses in science and mathematics are identical for the two programs; these are shown in the recommended sequence of courses for the bachelor of science degree. The difference in the two programs lies in the distribution of courses in the humanities and social sciences.

The bachelor of arts degree requires a minimum of 120 semester hour credits and the bachelor of science degree requires 128 semester hour credits. Students continuing in The Graduate School at Lehigh or who have appropriate noncredit educational experiences may graduate with fewer than 128 credits upon approval of the dean of the college.

Course Requirements for the B.S. in Chemistry in Recommended Sequence

freshman year (see page 46) (31 credit hours)

sophomore year, first semester (17 credit hours)

Chem 31	Chemical Equilibria (3)
Chem 51	Organic Chemistry (3)
Chem 53	Organic Chemistry Laboratory (1)
Chem 57	Organic Synthesis Laboratory (1)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Math 23	Analytical Geometry and Calculus III (4)

sophomore year, second semester (15 credit hours)

Chem 52	Organic Chemistry (3)
Chem 54	Organic Chemistry Laboratory (2)
Chem 187	Physical Chemistry (3)
Math 205	Linear Methods (3)
Eco 1	Economics (4)

junior year, first semester (16 credit hours)

Chem 188	Physical Chemistry Laboratory (2)
Chem 191	Physical Chemistry (3)
Chem 234	Analytical Chemistry Laboratory (1)
Chem 332	Analytical Chemistry (3)
Chem 358	Advanced Organic Chemistry (3)
Ger 1	Elementary German (or approved substitute) (4)

junior year, second semester (16 credit hours)

Chem 307	Inorganic Chemistry (3)
Chem 384	Advanced Chemical Experimentation (2)
Chem 338	Advanced Analytical Chemical Laboratory (1)
Ger 2	Elementary German (or approved substitute) (4)
	General Studies requirement (6)

senior year, first semester (16 credit hours)

Chem 381	Radiation and Structure (3)
Chem	elective (3)
	electives (10)

senior year, second semester (17 credit hours)

Chem	elective (2)
	electives (15)

Chemistry electives may be chosen from any two 200 or higher-level courses in science or engineering. At least one chemistry elective must include a laboratory. French 1 and 2, or Russian 1 and 2 may be substituted for German 1 and 2.

B.S. in Biochemistry

The undergraduate curriculum leading to a bachelor of science degree in biochemistry is based on the standard freshman year and the normal sophomore year of the chemistry curriculum.

Concentration in biochemistry courses takes place in the junior and senior years at the expense of some electives and of two courses in the normal chemistry curriculum. Consequently, graduates of this program are prepared to go into graduate work in several fields-medicine, biochemistry, chemistry, biophysics, and biology.

This curriculum requires 129 semester-hour credits. Students continuing in graduate school at Lehigh or who have appropriate noncredit educational experiences may graduate with fewer than 129 credits upon approval of the dean of the college.

Course Requirements for the B.S. in Biochemistry in Recommended Sequence

freshman year (see page 46) (31 credit hours)

sophomore year, first semester (17 credit hours)
same as chemistry

sophomore year, second semester (18 credit hours)

Chem 52	Organic Chemistry (3)
Chem 54	Organic Chemistry Laboratory (2)
Chem 187	Physical Chemistry (3)
Math 205	Linear Methods (or approved substitutes) (3)
Eco 1	Economics (4)
Biol	elective (3)

junior year, first semester (17 credit hours)

Chem 191	Physical Chemistry (3)
Chem 234	Analytical Chemistry Laboratory (1)
Chem 332	Analytical Chemistry (3)
Chem 371	Biochemistry I (3)
Chem 377	Biochemistry Laboratory (3)
Ger 1	Elementary German (or approved substitute) (4)

junior year, second semester (16 credit hours)

Chem 307	Inorganic Chemistry (3)
Chem 384	Advanced Chemical Experimentation (2)
Chem 338	Advanced Analytical Chemistry Laboratory (1)
Chem 372	Biochemistry II (3)
Ger 2	Elementary German (or approved substitute) (4)
Biochem, Biol, or Biophys	elective (3)

senior year, first semester (15 credit hours)

Chem 358	Advanced Organic Chemistry (3)
	General Studies requirement (3)
	biochemistry, biology, or biophysics electives (6)
	electives (3)

senior year, second semester (15 credit hours)

	General Studies requirement (4)
	biochemistry, biology or biophysics electives (3)
	electives (8)

Biology electives include Biol 21, 22, 28, 135, 320, 353 or others approved by the adviser; nine credits required. Biophysics electives include Phys 367, 368, Chem 303 or others approved by the adviser; three credits required. Biochemistry electives include Chem 350, 374, 378, Ch. E 340 or others approved by the adviser; two credits required. French 1 and 2 or Russian 1 and 2 may be substituted for German 1 and 2.

Undergraduate Courses in Chemistry

21. Introductory Chemical Principles (4) fall-spring
An introduction to important topics of chemistry. These include atomic structure, bonding in inorganic and organic compounds, states of matter, chemical equilibrium, acid-base theories and electrochemistry. Three lectures, one recitation. Prerequisite: Math 21, 31, or 41, previously or concurrently.

22. Chemical Principles Laboratory (1) fall-spring
A laboratory course to be taken concurrently with Chem 21. One three-hour laboratory period per week.

23. Environmental Aspects of Analytical Chemistry (3) spring
The fundamentals, theory, and practice of the analytical chemical methods used to examine air, water, and soil samples for trace impurities. Selected topics in the areas of classical and instrumental methods. Prerequisite: Chem 21.

31. Chemical Equilibria in Aqueous Systems (3) fall-spring
A study of the theoretical basis and practical application of equilibria in aqueous solutions, including acid-base, precipitation-solubility, metal-ligand, oxidation-reduction and distribution equilibria. Introduction to chemical thermodynamics, spectrophotometry, potentiometry and chromatography. The laboratory work emphasizes the qualitative and quantitative analysis of equilibria in aqueous media. Two lectures and one three-hour laboratory period. Prerequisites: Chem 21, Math 21, and Phys 11.

51. Organic Chemistry (3) fall
Systematic survey of the typical compounds of carbon, their classification, and general relations; study of synthetic reactions. Prerequisite: Chem 21. Schray or Young

52. Organic Chemistry (3) spring
Continuation of Chem 51. Prerequisite: Chem 51.

53. Organic Chemistry Laboratory (1) fall
Preparation of pure organic compounds. Modern techniques of characterization. Prerequisites: Chem 21; Chem 51 previously or concurrently. Course may not be followed by Chem 55.

54. Organic Chemistry Laboratory (2) spring
Continuation of Chem 53 with particular emphasis upon aromatic compounds and qualitative organic analysis. Prerequisite: Chem 53. Corequisite: Chem 52 concurrently.

55. Organic Chemistry Laboratory (2) spring
A course in the preparation of pure organic compounds and the techniques of organic chemistry applicable to both aliphatic and aromatic compounds. Prerequisite: Chem 51. Corequisite: Chem 52 concurrently. Course may not be taken by students who have had Chem 53.

57. Organic Synthesis Laboratory (1) fall
A course in preparative reactions and techniques for organic compound synthesis with emphasis on aromatic compounds. Intended for chemistry majors only. Corequisite: Chem 53 concurrently, or consent of the department chairperson.

187. Physical Chemistry (3) spring
Development of the principles of thermodynamics and their application to systems in which composition is of major concern: solutions, chemical and phase equilibria. Elements of chemical reaction kinetics. Prerequisites: Chem 31 or Met 210, and Math 21 or 43 previously or concurrently. Lovejoy or Zeroka

188. Physical Chemistry Laboratory (2) fall
Primarily for majors in chemistry. Qualitative observation of properties of matter and of dynamic processes involving composition and the relation of observations to conceptual models. Methods of data acquisition, treatment, assessment. Prerequisite: Chem 187. Sturm

191. Physical Chemistry (3) fall
Quantum chemistry of bonding and molecular structure. Elements of statistical thermodynamics. Microscopic structures of solids, liquids, interfaces, and polymers. Prerequisites: Chem 21, Math 23, and Phys 21. Lovejoy or Zeroka

192. Physical Chemistry Laboratory (2)
Laboratory studies that illustrate the various fields of study in experimental physical chemistry. Prerequisite: Chem 187. Sturm

193. Environmental Science Seminar (Biol 191, Geol 191) (1) fall and spring
Current developments in environmental science presented by students and discussed in seminar style. An interdisciplinary approach linking biological, geological, and chemical principles as they relate to causes and controls of environmental problems. May be taken more than once for credit. Prerequisite: sophomore standing.

194. Physical Chemistry for Biological Sciences (3) fall
The principles and applications of physical chemical concepts to systems of biological interest, including the gas laws, thermodynamics of metabolic reactions, colligative properties, electrochemical equilibria, reaction

kinetics and enzyme catalysis, and transport of macromolecules and viruses. Prerequisite: Chem 21. Lovejoy or Zeroka.

207. Metallic Elements (3) fall
A systematic study of the inorganic chemistry of the metallic elements and their major compounds with emphasis on the properties and structures of solid materials. Grouping of elements with similar properties within the periodic table is stressed. Prerequisite: Chem 21. Smyth

234. Analytical Chemistry Laboratory (1) fall
Laboratory course: experiments coordinated with and illustrating methods and principles discussed in Chem 332. Ohnesorge

250. Special Topics (1-3)
Selected topics in chemistry. May be repeated for credit when different topics are offered.

300. Apprentice Teaching in Chemistry (1-3)
See the first page of this section.

303. Nuclear and Radiochemistry (3)
A broad survey of nuclear science with particular emphasis on aspects of importance to chemistry and biology. Elementary nuclear theory, production, separation, and identification of radioactive and stable isotopes; use of isotopes in the study of chemical and biological systems; radiological safety; nuclear engineering. Two lectures and one lecture-laboratory. Prerequisite: Chem 187 or Chem 194, or consent of the department chairperson. Sturm

307. Advanced Inorganic Chemistry (3) spring
Selected topics in inorganic chemistry. Descriptive chemistry of the representative elements; introduction to transition metal complexes and the theories of bonding in these substances; kinetics and mechanisms of transition metal complex reactions; selected aspects of organometallic chemistry; bioinorganic chemistry. Prerequisite: Chem 191 or equivalent. Kraihanzel

310. Instrumentation Principles I (3) fall
Introduction to electronic instrumentation. Operational amplifiers and instrument design. Laboratory includes the design and construction of a useful electronic instrument of the student's choice. Typical project possibilities: EKG amplifier; analog computer for solving equations of state; electrochemical waveform generator. No prior electronics experience needed. Two lectures and one three-hour laboratory. Hazeyama

311. Instrumentation Principles II (3) spring
A continuation of Chem 310 emphasizing digital electronics. Digital-analog and analog-digital conversion. Introduction to microprocessors and microcomputers. The laboratory includes a design and construction project. Typical project possibilities include an alphanumeric oscilloscope display interface and a hardware multiply/divide unit for a microprocessor. Two lectures and one three-hour laboratory. Prerequisite: Chem 310, or consent of the department chairperson. Hazeyama

312. (ChE 312, Met 312) Fundamentals of Corrosion (3) fall
Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization and passivity. Nonelectrochemical corrosion including mechanisms, theories and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisites: Met 210 and Chem 187. Leidheiser

332. Analytical Chemistry (3) fall
Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry; interpretation of numerical data, design of experiments, solute distribution in separation methods. Prerequisites: Chem 31 and 51. Ohnesorge

334. Chemical Oceanography (3) fall
Chemistry of the oceans and other natural water systems, with emphasis on processes occurring at the interfaces with the air, the sediments, the rivers, and living organisms. Prerequisites: Chem 31 or 187, 51 or 52.

336. Clinical Chemistry (3) spring
Applications of analytical chemistry to clinical problems. Discussion of methods in common use and the biochemical-medical significance of the results. Prerequisites: Chem 332 and 52. Ohnesorge, Schray

338. Advanced Analytical Chemistry Laboratory (1) spring
A laboratory course in continuation of Chem 234. Experiments coordinated with and illustrating methods and principles discussed in Chem 332. Emphasis on spectrochemical, electroanalytical, and chromatographic techniques. Prerequisites: Chem 234 and Chem 332. Ohnesorge

340. The Chemist in Industry (2) fall
Structure and specific features of the chemical industry (raw materials, products, processes, markets, elements of cost competition, patents, safety, governmental regulation, use of research); decision-making and development of new products, processes, and uses; industrial careers for chemists; preparation for job interviews. LeMaistre

350. Special Topics (1-3)
Selected advanced topics in chemistry. May be repeated for credit when different topics are offered.

358. Advanced Organic Chemistry (3) fall
The study of modern theories of reaction mechanisms and their applications to the problems of organic chemistry. Prerequisite: one year of organic chemistry. Heindel or Young

368. Advanced Organic Laboratory (2)
The synthesis and study of organic compounds illustrating the important techniques and special pieces of apparatus commonly used in organic chemical research. Prerequisite: one year of organic chemistry and laboratory.

371. (Biol 371) Elements of Biochemistry I (3) fall
A general study of carbohydrates, proteins, lipids, nucleic acids, and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Prerequisite: one year of organic chemistry. Merkel or Alhadeff

372. (Biol 372) Elements of Biochemistry II (3) spring
Dynamic aspects of biochemistry: enzyme reactions including energetics, kinetics and mechanisms, metabolism of carbohydrates, lipids, proteins and nucleic acids, photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisite: Chem 371. Merkel or Alhadeff

375. Research Chemistry Laboratory (1-6) fall-spring
Advanced independent study or an investigation involving intensive work with faculty guidance in laboratory and library. Topics in active research in biochemistry, analytical, inorganic, organic and physical chemistry. Prerequisite: consent of the department chairperson.

377. Biochemistry Laboratory (3) fall
Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals. Prerequisite: Chem 371, previously or concurrently. Merkel or Alhadeff

378. Biochemical Preparations (2) spring
A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisites: Chem 377 and 372, previously or concurrently. Merkel or Alhadeff

381. Radiation and Structure (3) fall
Quantum chemistry and group theory applied to molecular orbital theory of bonding, structure, and spectroscopy. Study of selection rules for chemical and photochemical reactions. Prerequisites: Chem 191 and Math 205. Klier

382. Spectroscopy and Photochemical Kinetics (3) spring
Applications of electronic, infrared, and microwave spectroscopy to the study of molecular structure. Chemical consequences of intramolecular excitation; quantum efficiences and reaction mechanisms; pulse excitation and dynamics of elementary processes. Prerequisite: Chem 191. Lovejoy, Sturm

384. Advanced Chemical Experimentation (2) spring
An advanced laboratory course for chemistry majors which integrates library research, chemical syntheses, separations, purification methods, physical techniques and spectral characterization in the pursuit of mini-research problems. Written and oral reports required. Prerequisite: junior standing.

385. Physical Chemistry of Printing Inks (3) fall
Physical chemical mechanisms of printing processes; composition, dispersion processes for pigments, rheology and printability of inks; color-matching; development of solventless inks and specialty inks. Prerequisite: Chem 187 or equivalent. Vanderhoff

386. Catalysis (3) spring
Kinetics and thermodynamics of chemisorption and catalyzed reactions. The relation between the electronic and geometric structure of the catalyst and its selectivity to a desired product. Current and prospective major industrial processes will be discussed from fundamental chemical and physical principles. Prerequisite: Chem 187 or equivalent. Klier

388. (ChE 388) Polymer Synthesis and Characterization Laboratory (3) spring
Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties. Prerequisites: Chem 187, 191 and 51. Manson, El-Aasser

392. (ChE 392) Introduction to Polymer Science (3) spring
Introduction to concepts of polymer science. Kinetics and mechanisms of polarization; synthesis and processing of polymers, characterization. Relationship of molecular conformation, structure and morphology to physical and mechanical properties. Prerequisite: Chem 187 or equivalent. Manson, Sperling

393. (ChE 393, Met 343) Physical Polymer Science (3) fall
Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline and paracrystalline states (including visoelastic and relaxation behavior) for single and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology and behavior. Prerequisite: one year of physical chemistry. Manson, Sperling

394. (ChE 394) Organic Polymer Science (3) spring
Organic chemistry of synthetic high polymers. Functionality and reactivity of monomers and polymers. Theory of stepgrowth and chain-growth polymerization in homogeneous and heterogeneous media. Polymerization by addition, elimination, substitution and coupling reactions. Ionic, free-radical and coordination catalysis. Prerequisites: one year of physical chemistry and one year of organic chemistry. Manson, Vanderhoff

395. Colloid and Surface Chemistry (3) fall
Physical chemistry of everyday phenomena. Intermolecular forces and electrostatic phenomena at interfaces, boundary tensions and films at interfaces, mass and charge transport in colloidal suspensions, electrostatic and London forces in disperse systems, gas adsorption and heterogeneous catalysis. Prerequisite: Chem 187 or equivalent. Fowkes

396. Chemistry of Nonmetallic Solids (3) spring
Chemistry of ionic and electronic defects in nonmetallic solids and their influence on chemical and physical properties. Intrinsic and impurity controlled defects, nonstoichiometric compounds, defect interactions. Properties to be discussed include: diffusion, sintering, ionic and electronic conductivity, solid-state reactions, and photoconductivity. Prerequisite: Chem 187 or Met 210 or equivalent. Smyth

Graduate Programs in Chemistry

The department of chemistry offers graduate studies leading to several advanced degrees. In addition to the traditional master of science and doctor of philosophy degrees in chemistry, the department also offers a doctor of arts degree in chemistry (primarily for college-level chemistry teachers), a master of science and doctor of philosophy degree in physiological chemistry (primarily for certain specialties in the health sciences) and a master of science and doctor of philosophy degree in molecular biology. A master of science degree in clinical chemistry is also offered.

The doctor of arts degree includes broad course work in most of the major subdisciplines of chemistry and requires both a major and a minor field of specialization. A laboratory problem in chemistry (at the M.S. level) and a chemical-education project (at the doctoral level) are required. A teaching internship (Chem 411) and an industrial externship are part of the D.A. in chemistry which is particularly geared to the upgrading of college teachers presently employed in academia but not holding the doctorate.

The M.S. in clinical chemistry provides classroom and practicum training in the clinical laboratory sciences in both the university and a hospital setting. In addition to course work in advanced organic, analytical, and biochemistry the students also complete units in clinical and in pathophysiological chemistry. Admission to the program is open to qualified students from biology, medical technology, or chemistry backgrounds. Although the clinical chemistry degree is offered only at the M.S. level, it is integrated with the doctoral offerings of the department of chemistry and students are encouraged to continue their education to the Ph.D.

Information on the programs in physiological chemistry and in molecular biology is presented in Section IV.

Most of the chemistry facilities are housed in the 90,000-square-foot chemistry complex, first occupied in 1975. The seven-story Seeley G. Mudd Building affords laboratory space of modern design; the top three floors

are devoted to research laboratories. Most of the research laboratories in the adjacent Sinclair Laboratory are assigned to chemistry professors who specialize in research in surface and colloid chemistry.

Physiological chemistry research is located in Chandler-Ullmann Hall and in the Seeley G. Mudd Building. Solid-state chemical research is located in the Sherman Fairchild Laboratory, in Coxe Laboratory, in the Seeley G. Mudd Building, and in Sinclair Laboratory. Polymer chemistry research laboratories are located in Coxe Laboratory, Sinclair Laboratory, and the Seeley G. Mudd Building.

The graduate program in chemistry at Lehigh has a two-fold purpose. It affords a student the opportunity to acquire an advanced knowledge of chemistry within the framework of formal graduate courses and permits the development of competent research techniques through independent scientific investigation. The graduate program for the Ph.D. in chemistry consists of approximately one-third formal course work and two-thirds independent research and study. A student entering graduate study with a teaching assistantship typically spends four to five years of full-time residence beyond the bachelor's degree to complete all the requirements for the Ph.D. degree. Work for the master's degree can normally be completed in a year and a half.

During the first year of graduate work, students are mainly involved in basic courses in analytical, biological, inorganic, physical and polymer chemistry that carry graduate credit. The courses selected will be those appropriate for the student's degree program and his/her level of preparation. Students also become acquainted during this first year with the faculty members and their research interests so that the student can make an informed choice as to research interest and research director. This choice should be made by the end of the first year by either M.S. or Ph.D. candidates. Students who pass the Ph.D. qualifying exam in their field at the end of the first year or sometime in the second year will ultimately have a thesis committee appointed to serve in an advisory and examination capacity with respect to their research.

Current Research Projects

Current research projects of interest are listed below.

Analytical chemistry. Gas chromatograph-mass spectroscopy of trace organics, electrochemical reduction and oxidation mechanisms of organic compounds, clinical-biomedical applications, mechanisms of electrode processes, adsorption; environmental analytical chemistry (electrochemical, atomic absorption and chromatographic techniques); redox behavior of transition metal complexes.

Biochemistry. Production, isolation and characterization of proteolytic enzymes of marine bacteria; determination of the amino acid specificity of bacterial proteases; mechanism of action of proteolytic enzymes; collagenolytic enzymes of bacteria; factors affecting collagenase production in bacteria and tissues in culture; characterization of lysosomal glycosidases and glycosyltransferases; functional role of carbohydrates in glycoproteins; abnormal glycoprotein metabolism in human diseases.

Inorganic chemistry. Synthesis, characterization and chemistry of transition metal organometallic complexes with alkyl, carbonyl, nitroso, dinitrogen, dioxygen and phosphine ligands.

Organic chemistry. Synthesis of medicinal agents, correlation of molecular structure with pharmacological behavior; chemical models for biochemical reactions; sulfur bonding in novel heteroaromatic sulfur compounds; biosyntheses involving indole intermediates; mechanism of formation and structure of melamin; synthesis of new heterocyclic systems; mechanisms of phosphoglucose isomerase and aldolase; synthesis and phosphoryl transfer of phosphate esters of biological interest; radio pharmaceuticals.

Physical chemistry. Colloid and surface research include latexes, surface coatings, colloidal stability, adhesion, surface properties of catalysts, surface spectroscopy, surface calorimetry and ice nucleation. Solid-state chemistry includes studies of point defects in oxides and oxide growth. Other fields include flash photochemistry and kinetic spectroscopy, structure determination (bond lengths and angles) of gaseous compounds from vibration-rotation spectra using infrared spectroscopy, nuclear magnetic resonance and applications of quantum mechanics and statistical mechanics to problems of chemical interest.

Polymer chemistry. Synthesis, structure, conformation and properties of high polymers; techniques and kinetics of emulsion polymerization and film formation; acoustic, optical, permeability, dielectric and mechanical behavior of thin films, coatings and bulk polymers; molecular structure, relaxation behavior and energetics of fracture; elastic and viscoelastic behavior of interpenetrating and rubbery networks; effects of ordering in the glassy state and crystallization on physical properties; crystallization under the influence of shear gradients; physical chemistry of polymer composites such as polymer-concrete and filled polymers; interfacial characteristics and interactions in polymer-inorganic systems.

Major Instrumentation

Special equipment available for graduate research in chemistry is as follows:

Electron microscope, scanning electron microscope, electron microprobe, optical microscopes, precision mass spectrometer. Finnegan GC mass spectrometer, nuclear magnetic resonance spectrometer, electron spin resonance spectrometer, various double-beam infrared, visible, and ultraviolet spectrometers. Fourier transform infrared interferometer, atomic absorption spectrometer, spectrofluorometer, phosphorescence spectrometer, Auger spectrometer, ESCA spectrometer, high pressure catalytic reactors, selective chemisorption and circulating reactors, low-energy electron diffraction, Raman microprobe spectrometer, secondary ion mass spectrometer, scanning Auger spectrometer, Mossbauer spectrometer, liquid scintillation spectrometer, radiotracer equipment, flash photolysis apparatus, light-scattering photometer, preparative, analytical and disc ultracentrifuges, analytical and preparative gas chromatographs.

Also, vibron elastoviscometers, Weissenberg rheogoniometer, differential scanning calorimeter and other thermoanalytical equipment, gel permeation chromatograph, torsional modulus apparatus, vapor and liquid permeability equipment, dielectric capacitance bridges, MTS closed-loop hydraulic tester, torsion tensile testers, high-temperature tube furnaces, capacitance-voltage testing equipment, Wenking potentiostat, recording-multipurpose polarographs and chronopotentiometers, high-speed centrifuges, automatic fraction collectors, freeze dryers, automatic electrophoresis apparatus, laboratory fermentor, three work-in cold rooms, cell disintegrator, Warburg respirometer, zone and disc electrophoresis apparatus, paper column chromatography equipment, autoclave, isoelectric focusing equipment and high-resolution diode laser spectrometer.

There is also terminal access to the main university computer in the chemistry complex.

Graduate Courses in Chemistry

402. Physical Inorganic Chemistry (3) alternate years
Theories of bonding. Group theoretical principles will be utilized in studies of molecular orbital and ligand field theories of bonding. Prerequisite: Chem 191 or equivalent. Klier

403. Advanced Topics in Inorganic Chemistry (1-3) alternate years
Topics of contemporary interest in inorganic chemistry.

This course may be repeated when a different topic is offered. Prerequisite: Chem 307 or equivalent.

405. Organometallic Chemistry (3) alternate years
The chemistry of compounds containing carbon to metal bonds. Among topics covered are the following: organic compounds of the representative elements from Group I to IV; the chemistry of ferrocene and related pi-bonded organometallic complexes; metal carbonyl and nitrosyl complexes; dioxygen and dinitrogen complexes; organic synthesis utilizing organometallic catalysts. Prerequisites: Chem 307 and 358. Kraihanzel.

411. Teaching Internship (3-6) fall-spring
The preparation, teaching and grading of one or two undergraduate lecture courses with appropriate supervision by senior faculty members. Observation and evaluation of the intern is effected by classroom visits and videotape review. Prerequisite: candidacy in the doctor of arts program or permission of the department chairperson. May be repeated for credit.

421. Chemistry Research (1-6)
Research in one of the following fields of chemistry: analytical, inorganic, organic, physical, polymer, biochemistry.

423. Bio-organic Chemistry (3) alternate years
An examination of biochemistry on the basis of organic chemical principles. Emphasis on reaction mechanisms of biochemical transformations and methods for elucidation of these mechanisms, ie., kinetics, isotope effects, exchange techniques, inhibition studies, substrate analog effects and organic model studies. Prerequisite: Chem 358. Schray

424. Medicinal and Pharmaceutical Chemistry (3) alternate years
Principles of drug design, structure-activity relationships in antibacterial, antimalarial, anti-inflammatory and psychoactive drugs; synthesis and modes of action of pharmacologically active agents, radioactive pharmaceuticals. Prerequisite: one year of organic chemistry. Heindel

432. Advanced Analytical Chemistry (3) alternate years
Recent developments in analysis of chemical methods. Statistical methods in analytical chemistry: treatment and interpretation of numerical data; design of experiments; application to and discussion of multistage and other methods for separating chemical species. Prerequisite: Chem 332 or equivalent. Ohnesorge

433. Advanced Topics in Electrochemistry (3) alternate years
Theory and applications of selected electrochemical techniques; solutions to mass transport problems, treatment of electron transfer kinetics and kinetics of associated chemical reactions, and critical evaluation of adsorption and other factors associated with electrochemical processes. Prerequisite: Chem 332 or equivalent. Ohnesorge

435. Topics in Clinical Chemistry (3)
Selected aras of clinical chemistry such as chemical toxicology, pathogenic microbial biochemistry *in vivo* diagnostic methodology, therapeutic drug monitoring, or other advanced topics. May be repeated for credit when a different topic is offered.

436. Special Topics in Analytical Chemistry (1-3)
Topics of contemporary interest in analytical chemistry. May be repeated for credit when a different topic is offered. Ohnesorge, Simmons, Daves

437. Pathophysiological Chemistry (3) spring
Biochemical basis of human diseases involving abnormal metabolism of proteins, nucleic acids, carbohydrates, and lipids. Emphasis on the correlation of the clinical presentation of disease processes seen as physiological dysfunctions with clinical laboratory methods. Lectures, student presentations, and clinical case discussions. Prerequisite: consent of the department chairperson. Alhadeff

441. Chemical Kinetics (3) alternate years
A study of kinetic processes. Phenomenological chemical kinetics; order, mechanism effect of external variables on rate. Theories of the rate constant. Relation between thermodynamics and kinetics. Applications to selected systems such as unimolecular decompositions, molecular beams and diffusion-limited processes. Prerequisite: one year of physical chemistry. Sturm

443. (Met 443) Solid-State Chemistry (3) alternate years
Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids, dielectrics, surface states and surface fields in crystals. Prerequisites: one course in linear algebra and one course in quantum mechanics. Klier

445. Elements of Physical Chemistry (4) spring
Quantum chemistry of simple systems, molecular structure and spectroscopy, statistical and classical thermodynamics, and principles of kinetic processes. Lovejoy, Sturm, Zeroka

447. (Biol 447) Experimental Molecular Biology (3)
A survey of current research in molecular biology.

451. Theoretical Organic Chemistry (3) alternate years
Advanced theoretical and mechanistic organic chemistry with emphasis on molecular orbital and group theoretical treatments of structure, spectra, and reactivity of pi-electron systems. Typical applications include conservation of orbital symmetry in pericyclic reactions, and studies of electrophilic, nucleophilic and homolytic substitution reactions of aromatic compounds. Young

453. Heterocyclic Compounds (3) alternate years
An intensive study of the syntheses, reactions and properties of heteroaromatic compounds including derivatives of thiophene, pyrrole, furan, indole, pyridine, quinoline, the azoles and the diazines—all considered from the viewpoint of modern theories of structure and reaction mechanisms. Prerequisite: Chem 358. Young

458. Topics in Organic Chemistry (1-3)
An intensive study of limited areas in organic chemistry. May be repeated when a different topic is offered. Young, Heindel, Schray

466. Advanced Organic Preparations (2-3)
A laboratory course of instruction in advanced techniques of the preparation of organic compounds.

475. Advanced Topics in Chemistry (1)
Audiovisual courses in topics such as acid-base theory, NMR and mass-spectroscopy interpretation; course material obtained from the American Chemical Society. May be repeated for credit.

476. Microbial Biochemistry (3)
Composition, nutrition and metabolism of microorganisms. Major emphasis will be placed on bacteria: the nature of the macromolecules which go into their structures; assembly processes, generation of energy by photosynthetic or chemosynthetic processes, metabolism and control of metabolic reactions. Prerequisite: Chem 372 or equivalent. Merkel

477. Topics in Biochemistry (1-3)
Selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins. May be repeated for credit when different topics are offered. Prerequisite: consent of the department chairperson. Merkel or Alhadeff

479. Biochemical Techniques (1-3)
Laboratory studies of the techniques and principles involved in the isolation, identification, and biochemical transformation of carbohydrates, lipids, nucleic acids and proteins. Prerequisite: Chem 371 or its equivalent previously or concurrently. Merkel or Alhadeff

480. Advanced Biochemical Preparations (1-3)
An advanced laboratory course in the preparation, isolation, purification, and identification of biochemically produced materials. Emphasis is placed on materials and procedures of current interest in biochemistry. Prerequisite: consent of the department chairperson. Merkel or Alhadeff

481. Chemistry Seminar (1)
Student presentations on current research topics in the student's discipline but not on subjects close to the thesis. A one-hour presentation and attendance at other presentations are required for credit. May be repeated for credit, up to six times.

482. (ChE, Met 482) Engineering Behavior of Polymers (3) spring
Mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture, and aging on mechanical behavior. Robinson

483. (ChE 483) Emulsion Polymers (3) fall
Fundamental concepts important in manufacture, characterization, and application of polymer latexes. Topics include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation and various application problems. Prerequisite: previous course in polymers. Vanderhoff

484. (ChE, Met 484) Crystalline Polymers (3) spring
Morphology and behavior of both polymer single crystals and bulk crystallized systems. Relationship between basic crystal physics, thermal and annealing history, orientation and resulting properties. Thermodynamics and kinetics of transition phenomena and a brief treatment of hydrodynamic properties and their relationship to crystallization and processing properties.

485. (ChE, Met 485) Polymer Blends and Composites (3) fall
Synthesis, morphology and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated solids and fiber and particulate-reinforced polymers are emphasized. Prerequisite: any introductory course in polymers. Manson, Sperling

487. Topics in Colloid and Surface Chemistry (3)
Applications of colloid chemistry; special topics in surface chemistry. Lectures and seminar. May be repeated for credit as different topics are covered. Prerequisite: Chem 395. Fowkes, Micale, Vanderhoff

488. Advanced Topics in Physical Chemistry (1-3)
Advanced topics in physical chemistry, such as photochemistry and molecular beam dynamics. Fourier transform spectroscopy, kinetics of rapid reactions, theory of magnetic resonance. May be repeated for credit when different topics are offered.

492. (ChE 492) Topics in Polymer Science (3)
Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered. Prerequisite: Chem 392 or equivalent.

494. Quantum Chemistry (3) alternate years
Principles and applications of quantum mechanics to chemical problems. Applications to chemical bonding, molecular structure, reactivity and spectroscopy. Prerequisite: Chem 445 or consent of the department chairperson. Zeroka

495. Statistical Thermodynamics (3) alternate years
Principles and applications of statistical mechanics to chemical problems. A study of the techniques for evaluating the properties of matter in bulk from the properties of molecules and their interactions. Prerequisite: Chem 445 or consent of the department chairperson. Zeroka

Chinese

See listings under the department of modern foreign languages and literature, page 194.

Civil Engineering

Professors. David A. VanHorn, Ph.D., *chairperson;* Lynn S. Beedle, Ph.D., director, Fritz Engineering Laboratory; J. Hartley Daniels, Ph.D.; George C. Driscoll, Ph.D.; Hsai-Yang Fang, Ph.D.; John W. Fisher, Ph.D.; Ti Huang, Ph.D.; Robert L. Johnson, Ph.D.; Celal N. Kostem, Ph.D.; Irwin J. Kugelman, Sc.D., director, Center for Marine and Environmental Studies; John O. Liebig, Jr, M.S.; Le-Wu Lu, Ph.D.; Alexis Ostapenko, Sc.D.; Roger G. Slutter, Ph.D.; Robert M. Sorensen, Ph.D.; Ben-Tseng Yen, Ph.D.
Associate professors. Ronald C. Chaney, Ph.D.; George A. Dinsmore, M.S.; Peter Mueller, Dr. sc. techn.; Paul J. Usinowicz, Ph.D.; Richard N. Weisman, Ph.D.; John L. Wilson, Ph.D.
Assistant professor. Gerard P. Lennon, Ph.D.

Civil engineering occupies a prominent position as one of the major fields in the engineering profession. Civil engineers are concerned with all aspects of the conception, planning, design, construction, operation, and maintenance of major physical works and facilities that are essential to modern life. Civil engineering projects are typically characterized by extreme size, complexity, durability, and cost. Examples include bridges, buildings, transportation facilities, tunnels, coastal facilities, dams, foundations, waterways, sewerage and sewage treatment facilities, and water supply and purification systems.

The undergraduate program includes a strong base of mathematics and the physical sciences, followed by a broad range of courses in the areas of engineering science and civil engineering analysis and design. In civil engineering, the courses extend across the areas of structural, geotechnical, hydraulic, environmental, and transportation engineering, along with planning,

economics, probability and statistics, and surveying and measurements. The program is enriched with a series of required and elective courses in the humanities and social sciences. In addition, there are a number of elective opportunities to enable students to pursue areas of particular interest. Over the entire curriculum, emphasis is placed on the development of a solid knowledge of civil engineering fundamentals. Concomitantly, the program is threaded with instruction and opportunities in utilizing the computer, including computer graphics, throughout the field of civil engineering.

The civil engineering program prepares individuals for entry into the engineering profession or for entry into high quality programs of graduate study. With proper selection of electives, students may also prepare for entrance into schools of law or medicine, or into master's-level programs in engineering management or business administration.

For students interested in geological engineering, a five-year program is available, leading to two bachelor of science degrees, in civil engineering and in geological sciences. The program is outlined on page 112.

Recommended Sequence of Courses

freshman engineering year (see page 46)

sophomore year, first semester (17 credit hours)

Math 23	Analytic Geometry and Calculus III (4)
Geol 101	Geology for Engineers (3)
Mech 1	Statics (3)
CE 40	Plane Surveying (3)
Eco 1	Economics (4)

sophomore year, second semester (16 credit hours)

Math 205	Linear Methods (3)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
CE 11	Engineering Graphics (2)
Mech 11	Mechanics of Materials (3)
CE 121	Mechanics of Fluids (3)

summer (3 credit hours)

CE 41	Route and Higher Surveying (3)

junior year, first semester (17 credit hours)

CE 115	Probability and Statistics in Civil Engineering (2)
CE 143	Soil Mechanics (4)
CE 159	Structural Analysis I (4)
CE 222	Hydraulic Engineering (4)
	General Studies requirement (3)

junior year, second semester (17 credit hours)

Met 92	Structure and Properties of Materials (3)
CE 200	Engineering Planning and Economics (4)
CE 160	Structural Design (4)
CE 170	Environmental Engineering Flow Systems (3)
	General Studies requirement (3)

summer

CE 100	Summer Employment (0)

senior year, first semester (15-18 credit hours)

CE 203	Professional Development (3)
Mech 104	Dynamics and Vibrations (3)
	General Studies requirement (3)
	elective (6-9)*

senior year, second semester (15-18 credit hours)

CE 207	Transportation Engineering (3)
	Engineering Science elective (3)
	General Studies requirement (3)
	elective (6-9)*

*Please refer to description of normal program, page 46.

Elective opportunities total 15 to 21 credit hours, with at least three credits to be in engineering science. The selection of elective courses is to be in consultation with student's academic adviser in the department of civil engineering.

Undergraduate Courses

11. Engineering Graphics (2) spring
Use of drawing instruments; freehand, lettering and shape description; theory of orthographic projection, revolution, and pictorial representation; theoretical problems in space relationships between points, lines and planes; surfaces as loci. Emphasis on visualization and geometric logic. Dinsmore

40. Plane Surveying (3) fall
Study of the sources, magnitude, effects and removal of systematic errors and reduction of random errors in linear and angular measurements; effect of errors on computations. Care of and field techniques with the steel tape, engineers transit and engineers level. Study of linear measurements, differential leveling, direction of lines, the compass, angular measurements, traverse surveys and calculations; stadia, field astronomy, horizontal and vertical control. Field and office work. Prerequisite: Completion of freshman year in engineering or consent of the department chairperson. Liebig or Slutter

41. Route and Higher Surveying (3) summer
Land, topographic, and engineering surveys, including map compilation and drawing of plan, profile, and cross-sections; coordinate systems, earthwork simple, compound, spiral and parabolic curves. Daily recitations and field work for a three-week period. Prerequisite: CE 40. Liebig and Slutter

100. Summer Employment (0)
During the summer preceding the senior fall semester, which includes CE 203, students spend at least eight weeks in practical work, preferably in the field that the individual plans to enter after graduation. A written report on the experience obtained is due on return from summer vacation. Prerequisite: senior standing.

104. Readings in Civil Engineering (1-3)
Study of selected technical papers, with abstracts and reports. May be repeated for credit. Prerequisite: consent of the department chairperson.

115. Probability and Statistics in Civil Engineering (2) fall
Basic concepts of probability; probability distributions; estimation of parameters; regression and correlation. Emphasis on applications to civil engineering problems; structural reliability, random loading, traffic flow and control, and water-resource problems. Prerequisites: Math 23; Mech 11, previously or concurrently.

121. Mechanics of Fluids (3) spring
Fluid properties and statics; concepts and basic equations for fluid dynamics. Forces caused by flowing fluids and energy required to transport fluids. Dynamics similitude and modeling of fluid flows. Includes laboratory experiments to demonstrate basic concepts. Prerequisite: Mech 1.

140. Special Topics in Surveying (3) spring
Geodetic coordinates, map projections, triangulation, photogrammetry, construction surveys, hydrographic surveys, underground surveys, adjustment of horizontal and vertical control nets, precise leveling, doppler satellite surveys, and aerial pollution control surveys. Field and office work. Prerequisite: CE 41. Limited enrollment. Slutter

143. Soil Mechanics (4) fall
Fundamental physical, chemical and mechanical properties affecting the engineering behavior of soils. Identification; classification; permeability; effective stress and pore water pressures; compaction, compression and consolidation; stress-strain behavior and shear strength; laboratory tests for engineering properties; application of theories and principles in engineering practice. Prerequisite: Mech 11 or consent of the department chairperson.

158. Structural Laboratory (2) spring
Study of behavior of simple structural members. Planning, testing, and reporting. Acquisition, analysis, and presentation of experimental data. Steel, reinforced concrete, and other materials. Prerequisites: CE 160 and Met 92, previously or concurrently.

159. Structural Analysis I (4) fall
Elastic analysis of statically determinate frames and trusses; deflections by the method of virtual work and moment area; force method analysis of indeterminate structures; moment distribution concept. Prerequisite: Mech 11.

160. Structural Design (4) spring
Principles of structural design. Safety and economy. Strength, stability and serviceability criteria. Selection of simple structural members to resist tensile, compressive, bending, and shearing loads. Various structural materials will be covered, especially steel and reinforced concrete. Prerequisite: CE 159.

170. Environmental Engineering Flow Systems (3) spring
Quantitative analysis of water sources. Analysis and design of transmission and distribution of water; collection of wastewater and stormwater. Demonstration laboratories for water and wastewater treatment processes. Prerequisites: Chem 21 and CE 121.

200. Engineering Planning and Economics (4) spring
Principles of systems planning of civil engineering projects, including technical, political, economic, social and environmental factors; urban planning; plan implementation; decision-making; management techniques and reporting; principles of optimization. Prerequisite: junior standing. Dinsmore

203. Professional Development (3) fall
Elements of professionalism; professional ethics; engineering registration; continuing education; responsibilities of an engineer in industry, government, private practice; role of professional and technical societies, management and law in engineering; patents, unions. Prerequisite: consent of the department chairperson. Liebig

205. Design Problems (1-6)
Supervised individual design problems, with report. Prerequisite: consent of the department chairperson.

207. Transportation Engineering (3) spring
Principles of the design of transportation facilities with emphasis on highways and airports in the areas of geometric, drainage, and pavement design. Design problems. Prerequisites: CE 41 and senior standing. Liebig

209. Numerical Methods in Civil Engineering (3)
Application of numerical computational methods in civil engineering problems; emphasis on computer usage. Matrix manipulation; linear and non-linear equations; numerical integration; differential equations; finite differences. Numerical formulation techniques; and interpretation of computing results. Prerequisites: Engr 1 and Math 205.

211. Research Problems (1-6)
Supervised individual research problems, with report. Prerequisite: consent of the department chairperson.

222. Hydraulic Engineering (4) fall
Flow measurements, pipe hydraulics, open-channel flow and river engineering, hydraulic structures and model studies. Laboratory experiments in applied hydraulics. Prerequisite: CE 121.

244. Foundation Engineering (3) spring
Application of the theories and principles of soil mechanics to foundation design. Site investigations and engineering tests to evaluate subsoil conditions. Bearing capacity and settlement analyses for building foundations. Lateral loads on retaining walls and bulkheads. Prerequisite: CE 143 or consent of the department chairperson. Fang

259. Structural Analysis II (3) spring
Analysis of statically indeterminate structures, methods of slope deflection and moment distribution; consideration of side-sway and nonprismatic members. Influence lines for determinate and indeterminate structures. Flexibility and stiffness matrix methods for computerized analysis. Use of computer library programs. Prerequisite: CE 159. Wilson or Ostapenko

261. Structural Steel Design (3) fall
Design of steel structures, including plate girders, other built-up members, trusses, frames, grillages, shell-type structures and thin-gage members. Additional topics include connections, composite beams, and fatigue and fracture concepts related to structural design. Prerequisite: CE 160. Ostapenko or Yen

263. Structural Concrete Design (3) fall
Design of reinforced concrete structural members and simple systems, including continuous beams, columns, frames, one-and two-way slabs, and footings. Deflection, cracking, and column slenderness. Introduction to prestressing and torsion. Prerequisite: CE 160. VanHorn or Daniels

271. Water and Wastewater Processes (3) fall
Introduction to, and design of, unit operations and unit processes involved in water and wastewater treatment facilities. Consideration of combinations to meet water quality requirements, either as water supply source or as receiving mantle. Prerequisite: CE 170.

280. Internship (3)
Individual opportunities for qualified advanced civil engineering students to obtain practical experience through association with civil engineers, architects and planners. Typical fields of practice include transportation, hydraulic engineering, environmental engineering, air pollution, regional and city planning, architectural planning, and public works engineering. A report is required. Prerequisite: senior standing. May be repeated once for credit.

300. Apprentice Teaching in CE (1-3)
See beginning of Section V page75.

309. Computer Programming (2) fall
Advanced concepts of Fortran programming in analysis and design. Emphasis on logical program requirements for proper and efficient execution. Addressing and dynamic core allocation. Use of compiler maps and loader maps. Creation and use of permanent files, magnetic tape, and update files. Prerequisite: consent of the department chairperson.

316. Civil Engineering Planning (3) spring
Project-oriented planning of one or two civil engineering projects of students' choice, with oral and written report;

task force approach, collection and analysis of data; consideration of technical and environmental factors; cost analyses. Interaction with consulting engineers and planners. Prerequisite: senior standing or consent of the department chairperson.

322. Hydromechanics (3)
Ideal fluid flow, vortex flow, creeping motion; laminar boundary layers, turbulent shearing stress and turbulent boundary layers; turbulent jets and diffusion. Prerequisites: Math 205 and CE 222.

323. Hydraulic Engineering Laboratory (3)
Laboratory experimentation on applied hydraulics, including hydraulic machinery, hydraulic modeling, flow measurement, and various hydraulic phenomena. Prerequisite: CE 222.

324. (Mech 323) Fluid Mechanics of the Ocean and Atmosphere (3)
Hydrostatics of the ocean and atmosphere. Vertical stability. Fluid motion in a rotating coordinate system. Geostrophic flow; ocean currents; surface and internal waves. Prerequisite: ME 231 or CE 121.

325. Hydrology (3) fall
Hydrologic cycle. Precipitation, evaporation, transpiration, infiltration, ground water, stream flow, hydrographs, floods, Statistical analysis applied to hydrology. Prerequisite: CE 222.

326. Ground Water Hydrology (3) spring
The study of subsurface water, its environment and distribution. Theory of ground water movement, Mechanics of well flow. Sea water intrusion, artificial recharge, basin development. Prerequisite: CE 222.

328. Open Channel Hydraulics (3) fall
Energy and momentum concepts, frictional resistance. Rapidly varied flow, gradually varied flow, river controls and channel structures. Prerequisite: CE 222.

332. Ocean Engineering (3) spring
Quantitative oceanographic information for engineers, with emphasis on the coastal zone. Navigation and energy systems; materials; pollution problems; brief survey of the offshore petroleum and mining industries; manned and telechiric undersea operations. Prerequisite: consent of the department chairperson.

333. Ocean Engineering Field Investigation (1-3) summer
Field studies in ocean engineering and involving participation in research investigations conducted at sea. Prerequisite: consent of the department chairperson.

341. Ground Improvement Engineering (3) spring
The mechanisms of soil stabilization; principles and techniques; grouting and injection methods; reinforced earth methods, dynamic consolidation; deep compaction; sand drains; laboratory and field studies. Prerequisite: CE 143 or equivalent. Fang

342. Experimental Geotechnical Engineering (3) fall
Experimental studies dealing with the measurement of soil properties in the laboratory and *in situ;* application of these properties to design; consolidation; strength of soils in triaxial compression, tensile strength, and other shear tests, including measurement of pore water pressures; model design and analysis; dynamic tests; field measurement of *in situ* soil properties; laboratory and field instrumentation. Prerequisite: CE 143 and senior standing. Fang

343. Seepage and Earth Structures (3) spring
Long- and short-term stability of embankments and cut slopes; numerical and graphical methods of stability analysis; seepage through soils; design of earth dams, embankments and excavations; influence of embankment stability; construction control, field measurement of pore pressures and earth movements; model studies. Prerequisite: CE 143 or equivalent. Fang or Chaney

352. Structural Dynamics (3)
Analysis of linear structural systems to time-dependent loads. Free and forced vibration. Classical and numerical methods of solution. Lumped-mass techniques, energy methods, and introduction to matrix formulation of dynamic problems. Application to design. Prerequisites: Math 205, CE 159, and Mech 104. Yen

359. Plastic Analysis and Design (3) spring
Plastic analysis and design of steel structures. Strength and behavior of frames and component parts beyond the elastic limit. Methods of predicting strength and deformation in the plastic range. Studies of industrial and multistory frames. Comparison of plastic design techniques with allowable-stress design methods. Current research. Prerequisite: CE 259 or consent of the department chairperson.

360. Structural Design Projects (3) spring
Design team approach to the analysis and design of bridges in steel and reinforced concrete, including truss, cable-stayed, arch and suspension bridges. Emphasis on the total design concept, including foundations, substructure and superstructure, with consideration of economy, strength, and performance. Prerequisites: CE 261 and CE 263. Daniels

365. Prestressed Concrete (3) spring
Principles of prestressing. Analysis and design of basic flexural members. Instantaneous and time-dependent properties of materials. Prestress losses. Additional topics may include continuity, partial prestressing, compression members, circular prestressing, etc. Prerequisites: CE 263 or consent of the department chairperson. Mueller or Huang

371. Environmental Health Engineering (3) spring
Engineering applications to public health; food and milk sanitation, solid wastes, vector control, communicable disease control. Institutional and industrial sanitation, housing, air pollution, bathing and recreational water quality. Prerequisite: senior standing.

374. Sanitary Engineering Analysis and Operations (3) spring
Applications of chemical theory, concepts of operations commonly used in water quality control; laboratory evaluations for design of processes in water and wastewater treatment. Prerequisite: CE 271.

376. Water Resources Engineering (3) fall
Utilization of principles of hydraulics, hydrology, and environmental engineering in problems of erosion and flood control, power, irrigation, navigation, and water quality control; economics and water law in river basin planning. Prerequisites: CE 222 and CE 170.

380. Design Projects (1-6) fall-spring
Design project work as a member of a team, probably including students from differing disciplines. The project attacks a situation that, when possible, relates to a problem of one of the local communities or industries. Specific projects are normally guided by faculty from several departments with consultants from off-campus. May be repeated for credit. Prerequisite: consent of the department chairperson.

381. Special Topics (1-3)
A study of selected topics in civil engineering, not included in other formal courses. Prerequisite: consent of the department chairperson.

385. Research Procedures Seminar (1) fall
Planning and execution of research projects, survey of current research, elements of proposals and budgets. Literature search procedures. Presentation of data, and of written and oral reports. Guidelines for visual aids. Beedle

Graduate Programs

Graduate studies in civil engineering enable the student to build upon the broad background of undergraduate education in preparation for professional practice at an advanced level, for research and development, or for teaching.

The selection of graduate courses and research opportunities offered in the department permits the development of individual program objectives that may be concentrated in one of the technical specialty areas, or, alternatively, may extend over the broad field of civil engineering. The department offers advanced work in the specialty areas of structural engineering, geotechnical engineering, hydraulic engineering, hydrology, coastal engineering, and environmental engineering, leading to the degrees of master of science, master of engineering, and doctor of philosophy.

A graduate program leading to the M.S. normally is concentrated in one, or possibly two, of the technical specialty areas, and consists of a number of courses designed to fulfill the individual student's program objectives. Each candidate for the M.S. is required to submit a thesis representing three to six credit hours (CE 491, listed below), or alternatively, a report based on a research course of at least three credits (CE 429, 439, 449, 469, 479, or 481). The balance of the program will consist of courses in the specialty area(s).

A graduate program leading to the M.Eng. degree stresses engineering applications and design. The courses may extend across the various specialty areas in civil engineering. Each candidate for the M.Eng. is required to complete an engineering project representing three to six credits (CE 460) in place of the thesis or research report required for the M.S.

The doctoral program, which leads to the Ph.D., normally includes courses in the major field, courses in minor fields, and a dissertation presenting results of original research. In addition, each candidate is required to have some education in one or two non-engineering fields. This requirement may be met by taking two courses (200 level or above), or by taking two foreign language courses, or by passing a foreign language proficiency examination. Holders of master's degrees planning to become candidates for the Ph.D. take a qualifying examination at the first opportunity following one semester in residence. After qualification, the program of work is formulated by the candidate, the candidate's departmental Ph.D. committee, and the department chairperson.

The laboratories of the department are located in the Fritz Engineering Laboratory. The laboratory offers outstanding facilities for research and instruction in structural engineering, geotechnical engineering, hydraulic engineering, hydrology, coastal engineering, environmental engineering, and related fields. In particular, the structural testing equipment includes dynamic testing machines, a five-million-pound universal hydraulic testing machine, and other special loading apparatus. The recently expanded hydraulic facilities include a wave tank, several flumes, a 10 cfs recirculating flow system, and two multipurpose tanks for model studies. An interdisciplinary relationship with the Center for Marine and Environmental Studies facilitates the development of research programs in environmental engineering. Brochures describing the research facilities and programs are available on request.

In addition to departmental courses, a number of courses offered by the departments of mechanical engineering and mechanics, chemical engineering, metallurgy and materials engineering, geological sciences, and biology may also be considered a part of the major field in civil engineering. A list of such courses is available through the department chairperson.

A number of research assistantships and teaching assistantships are available to provide financial aid to students of outstanding promise. The half-time research or teaching activities required of holders of assistantships provide a valuable educational experience that supplements the formal course offerings. The graduate course offerings of the department are programmed to fit the schedule of half-time assistants, and to accommodate part-time students. A very limited number of scholarships and fellowships are available to provide financial aid for full-time study.

Graduate Courses in Civil Engineering

403. Analytical Methods in Civil Engineering (3) fall
Analytical and numerical methods used in various fields of civil engineering. Matrix algebra in engineering analysis. Iterative, differencing, and discretization techniques, Energy principles and special methods. Treatment of typical differential equations in civil engineering. Introduction to theory of elasticity with some engineering applications. Prerequisite: Math 205 or equivalent. Ostapenko

408. Computer Methods in Civil Engineering (3)
Numerical and computer-oriented methods specially applicable to the solution of complex problems arising in various fields of civil engineering. Solutions of well- and ill-conditioned linear and nonlinear systems. Eigenvalue formulation of stability and dynamic problems. Reduction techniques, integration schemes for large structural systems. Optimal design by linear programming. Introduction to problem-oriented languages and computerized design. Prerequisites: CE 403 or equivalent, and working knowledge of Fortran 77 programming. Kostem or Wilson

409. Finite Element Method in Structural Mechanics (3) spring
Basic principles and equations governing the finite element method. Analysis of planar, axisymmetric, plate and articulated structures, with emphasis on analytical modeling. Accuracy and convergence studies, utilizing different discretizations and various types of elements. Case studies include application and extension to material nonlinearities, bridges, containment vessels, and soil-structure interaction. Prerequisites: CE 403 or equivalent; working knowledge of Fortran. Kostem or Wilson

424. Surface Water Hydrology (3) spring
The study of quantities in the flow of water in streams. Hydrographs. Application of statistical analysis and probability to hydrological problems. Drainage basin analysis. Prerequisite: CE 325 or equivalent.

425. Hydraulics of Sediment Transport (3)
Hydrodynamic forces on particles, settling velocity. Sediment transport in open channel: tractive force theory, bed load and suspension theory, total load and wash load. Bedform mechanics, cohesive channel hydraulics. Sediment transport in closed conduits. Shore processes and coastline hydraulics. Prerequisites: CE 121 and CE 222, and consent of the department chairperson.

428. Advanced Topics in Hydraulics (1-3)
Recent development in hydromechanics and hydraulics. Topics to be selected from: wave mechanics, theory of flow through porous media, dispersion, hydrodynamic forces on structures, potential flow, free streamline theory, open channel hydraulics, computer methods. Prerequisites: CE 322 and consent of the department chairperson. May be repeated for credit.

429. Hydraulic Research (1-6)
Individual research problems with reports. May be repeated for credit.

431. Geotechnical Ocean Engineering (3)
Study of the engineering and scientific aspects of soils flooring the oceans; soils and their distribution; theory and practice of sampling, laboratory and *in situ* testing, geophysical methods, and computerized data synthesis; biological, geochemical, and physical properties of the electrolyte-gas-solid soil system of the sea floor and the response of this system to applied static and dynamic forces. Prerequisite: CE 143 or equivalent.

437. Advanced Topics in Geotechnical Ocean Engineering (1-3)
Advanced study of selected topics in geotechnical ocean engineering, such as: physico-chemistry of ocean sediments; foundation design in soft sediments; instrumentation for deep-sea soil surveys. Selection of topics will depend on particular qualifications of the staff, as well as interest of students. Prerequisite: consent of the department chairperson. May be repeated for credit.

439. Ocean Engineering Research (1-6)
Individual research with reports. May be repeated for credit.

443. Advanced Soil Mechanics I (3) fall
The origin, composition, and physico-chemical properties of soils and their influence on the engineering properties and behavior of soils; transmission of water in saturated and unsaturated soils; advanced theory of compaction; compression and consolidation; theories of shear strength. Prerequisite: a course in soil mechanics.

444. Advanced Soil Mechanics II (3) spring
Fundamental and advanced theories of soil mechanics applicable to earth structures and foundation design; stresses in homogeneous and layered systems for ideal elastic, plastic and visco-elastic soils; lateral earth pressures, thermo-geotechnics. Prerequisite: CE 443.

445. Advanced Foundation Engineering (3) fall
Current theory and practice relating to the design of foundations for buildings and other structures. Analysis and limitation of settlements; bearing capacity analyses of shallow and deep foundations; flexible and rigid retaining structure design; dynamic effects; anchor and other special foundations; site investigations. Prerequisite: a course in soil mechanics. Fang

447. Advanced Topics in Geotechnical Engineering (1-3)
Advanced studies in selected subjects related to geotechnical engineering. The general areas may include: stress-strain-time relationships of soils, colloidal phenomena in soils, ground water flow and seepage, soil dynamics, soil plasticity, numerial methods applied to soil mechanics, earth dam design, theories of layered systems and their application to pavement design, rock mechanics. The studies specifically undertaken in any particular semester depend on the availability of staff and the interest of students. Prerequisite: consent of the department chairperson. May be repeated for credit.

449. Geotechnical Research (1-6)
Individual research problems relating to soil engineering, with report. Prerequisite: a course in soil mechanics.

450. Advanced Structural Theory I (3) spring
Statical and geometrical stability and degree of statical indeterminacy. Application of energy methods such as virtual work, minimum total potential, minimum complementary energy, and Castigliano's theorems. Introduction to force and displacement matrix analysis of structures. Daniels

451. Advanced Structural Theory II (3) fall
Specialized methods of analysis: column analogy, moment distribution. General treatment of deformation methods using matrix algebra. Selected topics in structural theory: influence lines, multi-story building frames, space structures. Introduction to finite element method; nonlinear problems. Prerequisite: CE 450. Driscoll

453. Structural Members and Frames (3) fall
General torsion of thin-walled open, closed, and combined open and closed cross-sections; general instability of thin-walled members; inelastic instability; special problems in stability. Desirable preparation: Mech 415. Prerequisites: CE 403 and consent of the department chairperson. Lu

454. Plate and Shell Structures (3)
Plates and slabs loaded transversely in their plane. Buckling and postbuckling behavior of elastic and inelastic plates. Membrane and bending analysis of cylindrical, rotational, and hyperbolic-paraboloidal shells. Emphasis on engineering methods. Design considerations. Prerequisites: CE 403 and consent of the department chairperson. Ostapenko

455. Advanced Structural Dynamics (3)
Analysis and design of structures to resist wind, earthquake, and blast loading. Matrix methods and computer applications. Non-linear and elasto-plastic response. Damping characteristics of structures and structural components, spectral analysis, dynamic instability. Characteristics of aerodynamic and seismic forces and nuclear blast. Introduction to vibration of three-dimensional structural systems. Prerequisites: CE 403, CE 352 or Mech 406, and CE 450 or equivalent. Kostem

457. Theory and Design of Steel Structures (3) spring
Analysis and design of steel structures; structural connections; composite steel-concrete systems and other components. Consideration of residual stress; brittle fracture; fatigue strength; fastener systems. Study of current research and application to design practice. Fisher

459. Advanced Topics in Plastic Theory (3) fall
Fundamentals of the mathematical theory of plasticity; the general theorems of limit analysis and their applications to beams under combined loading, arches, space frames, plates and shells. Limit analysis of two-and three-dimensional problems in soil, concrete, rock, and metal. Current developments. Prerequisite: CE 359.

460. Civil Engineering Project (1-6)
An intensive study of one or more areas of civil engineering, with emphasis on engineering design and applications. A written report is required. May be repeated for credit.

462. Experimental Methods of Structural Analysis (3)
Analysis of structures using experimental techniques; use of mechanical devices in study of temperature deformations, foundation displacements, and integral action of structures; moire fringe method; theory of similitude with application to model design; structural analogies.

463. Experimental Methods of Structural Research (3)
Mechanical properties of structural materials and different procedures of evaluating these properties; experimental methods of stress analysis; statistical analysis of experimental data.

464. (Mech 416) Analysis of Plates and Shells (3)
Bending of rectangular and circular plates, plates under lateral loads, plates with thermal and inelastic strains, effect of in-plane forces, large deflections, buckling of

plates. Geometry and governing equations of shells, shells of revolution, membrane states, edge solutions, solution by numerical integration, nonsymmetric problems, buckling of shells, applications to pressure vessels. Prerequisites: Math 205; Mech 305, or equivalent course in advanced mechanics of materials. Kalnins or Updike

465. Advanced Topics in Concrete Structures (3) fall
Advanced topics in reinforced concrete with or without prestress. Analysis and design for torsion. Limit design concepts. Design of slab systems: strength design method, yield line theory and strip method. Other topics may include composite members, probabilistic basis of design codes, and building and bridge design. Prerequisites: CE 263 and CE 365 or equivalent, or consent of department chairperson. Huang or VanHorn

466. Concrete Shell Structures (3)
Analysis and design of concrete shell structures. Folded plates, cylindrical shells, and shells of double curvature. Typical practical problems. Prerequisites: CE 403 and consent of the department chairperson. Ostapenko

467. Advanced Topics in Structural Engineering (1-3)
Advanced study of selected topics in structural mechanics and engineering, such as: finite element methods, suspension systems; space frames; stability of nonlinear systems; coldformed and lightweight construction; optimization and reliability; second-order phenomena in structures; interaction of structures with the environment; structural use of plastics; composite construction, etc. Selection of topics will depend on particular qualifications of the staff, as well as on the interests of the students. Prerequisite: consent of the department chairperson. May be repeated for credit.

468. (Mech 415) Stability of Elastic Structures (3)
Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilever column. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Buckling by torsion and flexure. Variational methods. Buckling of frames. Instability problems of thin plates and shells. Prerequisite: Math 205. Kalnins

469. Structural Research (1-6)
Individual research with reports. May be repeated for credit.

471. Water Treatment Facilities (3) fall
Theory and design of water treatment facility components, from source to distribution system. Laboratory work in water chemical parameter determinations for design applications. Prerequisite: CE 374. Johnson or Usinowicz

472. Water Pollution Control Facilities (3) spring
Fundamental principles and design of water pollution control facilities for domestic and industrial waste water. Physical-chemical and biological studies in laboratory determination of design parameters to be applied in design procedures. Prerequisite: CE 374. Johnson or Usinowicz

475. Advanced Topics in Water Resources (1-3)
Advanced study of selected topics in areas such as: physicochemical methods of water quality control; biological systems for waste-water treatment; multiple use of water resources; and others. Selection of topics will depend on particular qualifications of the faculty as well as interest of the students. Prerequisite: consent of the department chairperson. May be repeated for credit.

479. Environmental Engineering Research (1-6)
Individual research problems in environmental engineering with summary report. May be repeated for credit.

481. Special Problems (1-6)
An intensive study, with report, of a special field of civil engineering which is not covered in the other courses. A design project or an interdisciplinary study of a problem related to civil engineering may also be included. May be repeated for credit.

483. Graduate Seminar (1-3)
Study of current topics in civil engineering.

491. Thesis (1-6)

Civil Engineering and Geological Sciences

This program is designed for students interested in geological engineering, and leads to two bachelor of science degrees, in civil engineering and in geological sciences, both awarded at the end of the fifth year. The total number of credits in the program in 183, including two summer camps which comprise nine credits.

The program provides alternatives for students who may decide not to complete the two-degree program. Students who make this decision prior to the beginning of the fourth year may qualify at the end of that year for the bachelor of science in civil engineering, as well as a minor in geological sciences. On the other hand, if a student decides after two years to pursue only the bachelor of science in geological sciences, it is possible to complete the requirements in four years. If the decision to work toward this degree is made during the fourth year, at least one additional semester is required to qualify for either bachelor degree. Interested students should consult with the undergraduate officer in the department of civil engineering.

freshman engineering year (see page 46)

second year, first semester (16 credit hours)

Math 23	Analytic Geometry and Calculus III (4)
Mech 1	Statics (3)
CE 40	Plane Surveying (3)
Chem 31	Chemical Equilibria in Aqueous Systems (3)
Geol 101	Geology for Engineers (3)

second year, second semester (19 credit hours)

Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Mech 11	Mechanics of Materials (3)
CE 11	Engineering Graphics (2)
CE 121	Mechanics of Fluids (3)
Geol 31	Historical Geology and Stratigraphy (3)
elective	humanities and social sciences (3)

summer (3 credit hours)

CE 41	Route and Higher Surveying (3)

third year, first semester (19 credit hours)

Math 205	Linear Methods (3)
CE 115	Probability and Statistics in Civil Engineering (2)
CE 143	Soil Mechanics (4)
CE 222	Hydraulic Engineering (4)
Geol 133	Introductory Mineralogy and Petrology (3)
Geol 123	Structural Geology (3)

third year, second semester (17 credit hours)

Met 92	Structure and Properties of Materials (3)
CE 170	Environmental Engineering Flow Systems (3)
Biol 21	Principles of Biology (3)
Biol 22	Introduction to Biology Laboratory (1)
Eco 1	Economics (4)
Geol 356	Ground Water (3)

summer

CE 100	Summer Employment (0)

fourth year, first semester (19 credit hours)

CE 159	Structural Analysis I (4)
Geol 301	Introduction to Geophysics (3)
Geol 313	Sedimentology (3)
Geol 333	Crystallography (3)
Mech 104	Dynamics and Vibrations (3)
Geol 356	Ground Water (3)

fourth year, second semester (18 credit hours)

CE 160	Structural Design (4)
CE 200	Engineering Planning and Economics (4)
Geol 312	Geomorphology (3)
Geol 334	Petrology and Petrography (4)
elective	engineering science (3)

summer (6 credit hours)

Geol 341	Field Geology (6)

fifth year, first semester (18 credit hours)

CE 203	Professional Development (3)
elective	Civil Engineering (3)
elective	Geology (3)
electives	humanities and social sciences

fifth year, second semester (18 credit hours)

CE 207	Transportation Engineering (3)
elective	Civil Engineering (3)
elective	Geology (3)
electives	humanities and social sciences (9)

Classics

Professor. Douglas D. Feaver, Ph.D.
Associate professor. Charles Robert Phillips, III, Ph.D., *chairperson.*
Assistant professor. Amy E. Richlin, Ph.D.

The study of classics examines firstly the origins and growth of Greek and Roman culture in the Mediterranean area and secondly its impact on that area (and others) until the present. This study is by nature interdisciplinary: the study of language and literature, history, philosophy and religion, archaeology, economics and science all contribute to an appreciation of Greco-Roman civilization.

Students in either major or minor programs may concentrate in various combinations of these and other disciplines as they relate to ancient civilization. The diversity of professional interest in the department should encourage the student to follow her or his special interests while simultaneously gaining an overview of classical civilization.

Courses in Ancient Greek and Latin lead to proficiency in language while introducing the student to major literary texts. The Joseph A. Maurer Classics Prize is awarded yearly, at the discretion of the department, to the senior who has demonstrated outstanding achievement in the study of Ancient Greek or Latin. Courses in classical civilization require no knowledge of the ancient languages; they offer introductions to various disciplines of classics with frequent reference to modern perspectives. Upper-level courses tend to be small, fostering closeness between faculty and students.

Major programs. Students may major either in Classical Civilization or Classics. The Classical Civilization major has no language requirement, although students are encouraged to take language courses in partial fulfillment of major requirements. The Classics major offers a comprehensive view of language and culture; it is possible to begin an ancient language at Lehigh and to complete the major program successfully. Depending on interests and preparation, the student should derive equal educational benefit from either major program. The department welcomes double majors and the educational perspectives to be derived from combining ancient and modern studies.

Classics as a major has stood the test of time, offering helpful preparation for careers in widely diverse fields in the professions, business, and public service. Lehigh classics majors have gone on to law school, the ministry, business school, with appropriate science courses to medical school, graduate work in classics, and to all kinds of entry-level employment.

Minor program. The minor in Classical Civilization or Classics consists of a minimum of fifteen credit hours. Students may focus on any aspect of classical studies, either singly or in combination. The department can arrange individual programs.

Study abroad. Lehigh University is a cooperating institution of the Intercollegiate Center for Classical Studies at Rome and of the American School of Classical Studies at Athens. Lehigh students are eligible for tuition grants at Athens and at Rome.

Note: Courses designated Clss are taught in English. No knowledge of Latin or Ancient Greek is involved.

Major in Classical Civilization

This major allows the student to concentrate either in classical archaeology or classical literature while gaining an overview of Greco-Roman culture. No knowledge of ancient languages is required, although students may substitute six credit hours, with the department chairperson's consent, for required major courses. Students are encouraged to individualize their programs by means of appropriate collateral courses chosen in consultation with the department chairperson.

required preliminary courses (6 credit hours)

Clss 21	Greek History (3)
Clss 22	Roman History (3)

required major courses (24 credit hours in one of the areas of concentration)

Concentration in Archaeology

Clss 82	Art and Archaeology of Greece (3)
Clss 103	Archaeology of Italy (3)
Clss 108	Ancient Technology (3)
Clss 201	Archaeology: Lands of the Bible (3)
Clss 204	Ancient City and Society (3)
Anth 11 *or*	Sociocultural Anthropology (3)
Anth 12	Emergence of Mankind and Culture (3)

one course chosen from the area of classical literature (3)
one course chosen from the following: Clss 241, Clss 251, Phil 131, R.S. 111, 114 (3)

Concentration in Classical Literature

Clss 51	Masterworks of Greek and Roman Theatre (3)
Clss 52	Latin Literature in English Translation (3)
Clss 161	Roman Law (3)
Clss 250	Women in Antiquity (3)
Clss 251	Classical Mythology (3)

two courses chosen from the area of archaeology (6)
one course chosen from the following: Clss 241, RS 111, 114 (3)

Two courses in either Ancient Greek or Latin may be substituted (see above).

A comprehensive examination or senior essay is required in the area of concentration.

Major in Classics

This major allows the student to concentrate in Ancient Greek, Latin or both. Specific programs for this major are worked out for each student with due consideration for the individual's particular previous study of the language(s). Students wishing to concentrate in both languages should consult the department chairperson as soon as possible on their arrival at Lehigh. Thus a student may begin Ancient Greek or Latin at Lehigh and successfully complete a major in it. In general, the program requires as a minimum:

required preliminary courses (18 credit hours *maximum*, depending on previous language study)
Clss 21 Greek History (3)
Clss 22 Roman History (3)
either Greek 1, 2, 11, 12, or Latin 1, 2, 11, or 12, or appropriate placement as determined by the department chairperson.

required major courses (30 credit hours)
twelve credit hours in advanced courses in the major language
six credit hours in the second language, taken at any level
three credit hours in archaeology
three credit hours in philosophy/religion, chosen from the following: Clss 241, Clss 251, Phil 131, RS 111, 114
six credit hours from either classical civilization courses or approved collateral courses.

Either a comprehensive examination or a senior essay is required for graduation.

Courses in Classical Civilization (Clss)

21. (Hist 21) Greek History (3) fall
The development of civilization from palaeolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic and literary development of the ancient world; the origin of political institutions. Phillips

22. (Hist 22) Roman History (3) spring
Rome from its origins to A.D. 476. Political, social and religious developments. Transformation of the late Roman Empire to the early medieval period. Phillips

51. Masterworks of Greek and Roman Theatre (3) fall
Tragedies and comedies from ancient Greece and Rome. Effects of stage conventions and social norms on actor, playwright and play; lectures; discussion.

52. Latin Literature in English Translation (3)
Readings in major genres of Latin literature. Emphasis on epic, Roman comedy, and satire. No knowledge of the Latin language is required.

82. Art and Archaeology of Greece (3)
The art and architecture of ancient Greece as revealed by archaeology. Brief surveys of the political and cultural backgrounds to the various artistic periods: Bronze Age, Geometric, Orientalizing, Classical, Hellenistic and Roman. Lectures, slides and films. Feaver

103. Archaeology of Italy (3)
Neolithic, Terramaran, Villanovan and Etruscan cultures. Rome the city: its buildings, monuments and streets, through the kingdom, republic, and empire. Survey of Pompeii, Herculaneum and Ostia. Lectures, readings and reports. Feaver

108. Ancient Technology (3) spring
Technology and technique from the stone ages to the beginning of the industrial age; their effects on society. Attitudes to technology in ancient myth, literature, philosophy, and religion. Feaver

132. Medical Terminology (1-3)
Basic knowledge of Greek and Latin roots used in medical and health sciences. Rules for combining forms, for recognition of variants. Exercises in etymology.

161. Roman Law (3)
Examination of Roman legal systems from the *Twelve Tables* to the *Digest* of Justinian. Emphasis on development of legal concepts and their historical context. Readings in primary sources; lectures; discussion. Phillips

201. Archaeology: Lands of the Bible (3)
Chronological survey of archaeological finds from Palaeolithic, Neolithic, Bronze Age, Iron Age, and later cultures in the Near East. Material illustrating the cultures and events of the Bible. Feaver

204. Ancient City and Society (3)
Ancient theories of city and city planning; attitudes to life in the city; rise of urban civilization from Neolithic prototypes through the Near East, Egypt, Greece, and Rome; insights applicable to current urban problems. Feaver

241. (RS 241) Paganism and Christianity (3)
Examination of religious groups in the Roman Empire as social phenomena. Reactions to historic circumstances. Similarity and divergence of religious experience. Readings in primary sources. Lectures and discussion. Phillips

250. Women in Antiquity (3)
Interdisciplinary study of women in Greece and Rome. Literary, archaeological and historical evidence and approaches. Introduction to ancient and modern theories of myth. Cross-cultural material. Richlin

251. (RS 251) Classical Mythology (3)
Myth, religion and ritual in ancient Greece and Rome. Emphasis on primary sources; introduction to ancient and modern theories of religion. Cross-cultural material. Phillips

281. Readings (3) fall
Advanced study of an historical period or theme. Emphasis on primary sources. Prerequisites: Clss 21 or 22 and consent of the department chairperson.

282. Readings (3) spring
Advanced study of an historical period or theme. Emphasis on primary sources. Prerequisites: Clss 21 or 22 and consent of the department chairperson.

Courses in Ancient Greek

1. Elementary Greek (3) fall
Fundamentals of the Greek language. Readings in the easier authors.

2. Elementary Greek (3) spring
Continued work in Greek vocabulary, forms, and syntax. Selected readings in Greek. Prerequisite: Gk 1.

11. Intermediate Greek (3) fall
Readings in Herodotus, Homer, or Xenophon. Grammar review. Prerequisites: Gk 1 and 2, or one year of entrance Greek.

12. Intermediate Greek (3) spring
Plato: *Euthyphro, Apology* and *Crito,* or other dialogues. Prerequisite: Gk 11.

111. Greek Drama (3) fall, alternate years
Representative plays of Sophocles, Euripides and Aristophanes. Literary study of the drama. Prerequisite: Gk 12.

112. Greek Drama (3) spring, alternate years
Continuation of Gk 111. Prerequisite: Gk 12.

113. Greek Historians (3) fall, alternate years
Selections from Herodotus, Thucydides or Xenophon. Study of Greek historiography. Prerequisite: Gk 12.

271. Readings (3) fall
Intensive readings in one author or in a selected genre. Prerequisites: six credit hours at the 100 level and consent of the department chairperson.

272. Readings (3) spring
Intensive readings in one author or in a selected genre. Prerequisites: six credit hours of courses at the 100 level and consent of the department chairperson.

Courses in Latin

1. Elementary Latin (3) fall
Fundamentals of grammar and syntax. Introduction to Ovid's version of Greek mythology. Emphasis on language structure and vocabulary building.

2. Elementary Latin (3) spring
Easy Latin prose and poetry. Prerequisite: Latin 1 or one to two years of entrance Latin.

11. Intermediate Latin (3) fall
Readings in Latin prose or poetry. Consolidation of reading ability; introduction to literary analysis. Prerequisite: Latin 2 or consent of department chairperson.

12. Intermediate Latin (3) spring
Readings in Latin prose or poetry. Consolidation of reading ability; introduction to literary analysis. Prerequisite: Latin 11 or consent of department chairperson.

165. Vergil (3)
Vergil; *Aeneid,* selections: study of the aesthetic, political and philosophical values of Vergil's poetry. Prerequisite: Latin 12 or consent of the department chairperson.

166. The Roman Lyric (3)
Selected poems of Horace and Catullus. Lectures on development of lyric poetry. Introduction to metrics. Prerequisite: Latin 12 or consent of department chairperson.

168. Latin Drama (3) spring
Readings of selected plays of Plautus, Terence, and Seneca. Prerequisite: Latin 12 or consent of department chairperson.

211. Readings (3) fall
Intensive readings in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of the department chairperson.

212. Readings (3) spring
Intensive reading in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of the department chairperson.

213. Ovid (3)
The *Metamorphoses* and major elegiac works. Development of Ovid's poetics. Prerequisite: six hours of courses at the 100 level or consent of the department chairperson.

303. The Roman Epic (3)
The epic in Latin literature; selections from Lucretius, Catullus and Ovid; critical study of Vergil's *Aeneid.* Prerequisites: six hours of courses at the 100 level and consent of the department chairperson.

Computing and Information Science

Professors. Edward F. Assmus, Jr., Ph.D.; Robert F. Barnes, Ph.D.; Samuel L. Gulden, M.A.; Donald J. Hillman, M. Litt, director, Center for Information and Computer Science; John J. O'Connor, Ph.D.; Murray Schechter, Ph.D.
Associate professors. James F. Gimpel, Ph.D.; Andrew J. Kasarda, Ph.D.; Edwin J. Kay, Ph.D.; Gerhard Rayna, Ph.D. *acting head.*

The technologies of computing and information management have created powerful forces for change in all aspects of human functioning. The discipline of computing and information science has arisen with the purposes of studying, applying, and controlling these important new tools. These are now fundamental in science, industry, and business. Computing and information science in its relation with mathematics, linguistics, and communication also reaches beyond technology into much wider areas of intellectual and social concern.

In order to prepare those who desire to enter this discipline, the division of computing and information science, associated administratively with the department of mathematics, offers a major program leading to a bachelor of science in computing and information science. The program provides a computing science option and an information science option, and consists of the following parts:

A. *The common introductory courses* for both the computing science and the information science options. (36 credit hours)

B. *University requirements and College of Arts and Science distribution requirements.* (36 credit hours)

and *one of the following:*
C. *The computing science option* (48 credit hours)
D. *The information science option* (48 credit hours)

The program requires a total of 120 credit hours.

A. *Introductory Courses* (36 credit hours)

Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)
Math 61	Logical Methods (3)
Math 205	Linear Methods (3)
Math 231	Probability and Statistics (3)
CIS 11	Introduction to Structured Programming (3)
CIS 12	Programming Techniques (3)
CIS 318	Computing Algebra (3)
*CIS 203	Advanced Programming (3)

and one of the following:

Math 243	Algebra (3)
CIS 317	Analytical Methods for Information Sciences (3)

*Students in the information science option may replace CIS 203 with CIS 362, Programming Languages (3).

B. University requirements and college distribution requirements (36 credit hours)
Freshman English (6 credit hours)
distribution (30 credit hours)
Thirty credit hours taken in courses outside the natural sciences and mathematics. Of these thirty credit hours, at least twelve credit hours must be taken in the humanities, and at least twelve in the social sciences. The selection must be approved by the student's adviser.

C. The computing science option (48 credit hours)
The computing science option includes requirements in two categories, as follows:

1. Computing science courses (27 credit hours)

Math 230	Numerical Analysis (3)
CIS 102	Foundations of Computing Science (3)
CIS 302	Software Systems I (3)
CIS 303	Software Systems II (3)
CIS 309	Mini-Micro Processor Software Design (3)
CIS 312	Computer Organization (3)
CIS 362	Programming Languages (3)
CIS 371	Readings and Project I (3)
CIS 372	Readings and Project II (3)

2. Professional electives (21 credit hours)
These courses are elected with the approval of the student's adviser. They may be chosen from any appropriate courses in the natural sciences, mathematical sciences, social sciences, computing and information sciences, engineering sciences, and business and economics.

These courses may be used to give an orientation to the student's course of study. For example, the student may want to elect physics and chemistry courses to prepare for the growing computer technology in energy and environmental studies. In addition, students who wish to turn to the use of the computer in business and finance might consider industrial engineering, economics, accounting, and finance courses.

D. The information science option (48 credit hours)
The information science option includes courses in three categories, as follows:

1. Behavioral foundations (12 credit hours)

Psych 1	Introduction to Psychology (3)
Psych 113	Psychological Research and Statistics (3)
Psych 307	Cognitive Psychology (3)
	electives (3)

2. Information science and technology (18 credit hours)

IE 18	Data Processing Fundamentals (3)
CIS 321	Introduction to Information Methodology (3)
CIS 374	Information Retrieval Theory (3)
IE 309	Information System Development (3)
IE 310	File Structure and Processing (3)
	electives (3)

3. Professional electives (18 credit hours)
The professional elective courses are chosen by the student, with the approval of the major adviser, to provide a specialized direction to the curriculum. These include courses in information processing, information transfer systems, man-machine relationships, library automation, educational systems, management systems, and the like.

Minor in Computing Science

For substitutions, consult the head of the division. CIS 11 or 17; Math 23 or 44; CIS 371 or Math 243; CIS 102; and CIS 241 or CIS 362 or Math 230.

Courses in Information and Computer Science

11. Introduction to Structured Programming (3)
Algorithmic design and implementation in high-level, block-structured, procedure-oriented languages. No prior computing experience required.

12. Programming Techniques (3)
Continuation of CIS 11. Prerequisite: CIS 11.

13. Computer Programming for the Humanities and Social Sciences (3) fall
An introduction to computer programming with special emphasis on the requirements of language-oriented applications. No previous knowledge of computer programming is required. Hillman

14. Computer Applications in the Humanities and Social Sciences (3) spring
Applications of computers to studies in the humanities and social sciences to obtain greater rigor and sophistication. Both quantitative and qualitative applications are covered, but special attention is given to recent developments of the latter sort, since these applications are often the more significant ones. Prerequisite: CIS 13 or equivalent. Hillman

17. Structured Programming Techniques (4) UP
Algorithmic design and implementation in high level, block-structured, procedure-oriented languages. Recursion, lexical programs, pointers, data structures, and their applications. Previous experience with programming required.

Note: CIS 17 constitutes an accelerated course for students with some programming experience, which can be used as a prerequisite in place of CIS 11 and 12.

102. Foundations of Computing Science (3)
Elementary discrete structures; algorithmic structures; introduction to machine organization, assemblers, loaders, languages. Prerequisite: CIS 11.

105. Assembly-Language Programming (3) fall
The translation of simple mathematical and logical problems into forms permitting their solution by digital computers, with emphasis on machine-language programming of several typical types of computers. Prerequisite: familiarity with a higher level language such as BASIC, FORTRAN, or PASCAL. Rayna

110. Algorithmic Process (3)
Abstract models of machine processes. Computability and unsolvability, generability, decidability, and acceptability as algorithmic processes. Barnes

111. Foundations of Information Science (3)
Fundamental properties of information systems and theories governing information system design. Inherent data structures and representation of knowledge. Logic, data bases, and decision support systems. Real world applications.

190. Special Topics (1-3)
Supervised reading and research. Prerequisite: consent of the head of the division.

201. Computers and Language
Language-related computer applications drawn from a variety of areas such as cryptography, word-processing, linguistics, and artificial intelligence. Prerequisite: CIS 11 or permission of the division head.

202. Computers and Society (3)
A general nontechnical survey of the impact of computers on modern society. Special attention is given to the use of large-scale data banks and retrieval systems, the problems

of privacy and file security, and the impact of automation on everyday life.

203. Advanced Programming (3)
Advanced information structures, list processing, symbolic processing, basic formal language theory, elementary parsing and interpreting algorithms, assembly language, introduction to computer organization. Prerequisite: CIS 12 or CIS 17.

217. (EdT 417) Instructional Programming Techniques in PASCAL (3)
A continuation of structured programming in PASCAL. Special emphasis on the application of sound, color, and graphics in of instructional courseware development. Prerequisite: Foundations of Instructional Programming in PASCAL.

221. Low-Cost Personal Retrieval Systems (3)
Systems for finding information quickly within a personal information collection. Applicable to collections gathered for study, research, hobby, or other purposes. Students develop systems for their own collections. Emphasizes nonmechanical systems, but with some study of possible computer use, including personal computers. For non-information science people; and also an introduction to retrieval for information science students.

230. Unconventional Applications of Computers (3)
How computers combine elementary operations to do complex jobs. How computers do unconventional things such as play chess, compose music, simulate psychiatrists, produce medical diagnoses. No previous knowledge of computers required.

241. Data Base Systems (3) fall
Data base concepts in terms of formal logic. Knowledge representation and deduction. Data base integrity. Query languages. Prerequisite: CIS 11 or approval of the division head.

301. Descriptive Linguistics (3) fall
Techniques for the description of the phonology, morphology, and syntax of natural languages. Special attention to transformational generative grammar. Rubenstein

302. Software Systems I (3)
Applications of formal language theory: LL(K), LR(K), and other parsing algorithms; design and implementation of compilers and interpreters. Prerequisite: CIS 203.

303. Software Systems II (3)
Assemblers, executive systems, multiprogramming, time-sharing. Concurrent tasks, deadlocks, resource sharing. Construction of a small operating system. Prerequisites: CIS 203 and 312.

309. Mini-Micro Processor Software Design (3)
Introduction to the development of software for a small computer. Prerequisite: CIS 203.

310. (HD 320/Psych 320) Psycholinguistics (3)
Study of the experimental and observational literature on psychological processes involved in the production, comprehension and use of language by adults. Rubenstein

311. (EdT 311) Foundations of Instructional Programming in BASIC (3)
The essential elements of programming methodology. Special emphasis on the BASIC language for microcomputers and its use in instructional programming. In addition, students are required to become familiar with a microcomputer disk operating system.

312. (EdT 419) Computer Organization (3)
Structured organization of digital machines, virtual processors; software compatibility. Prerequisites: CIS 102 and 203, or approval of the division head.

317. (ECE 317) Discrete Structures (3)
Series of topics in discrete mathematical structures chosen for their applicability to computer science and engineering. Sets; combinatorics; binary relations and ordering; lattices and Boolean algebra; graphs, trees; generating functions, recurrence relations; groups and rings. Various examples of applications such as job scheduling, sorting, transport networks and error-correcting codes.

318. Computing Algebra (3)
Continuation of 317. Formal languages, parsing, semantics. Prerequisite: CIS 317 or Math 243.

320. (Psych 308) Information Processing: Human and Machine (3) alternate years
Study of the identification, storage, retrieval and use of auditory and visual inputs in decision-making contexts. Human and mechanical information processes, their similarities and differences. Rubenstein

321. Introduction to Information Methodology (3)
History, theory, and structure of indexing and classification systems for the organization of information; comparative analysis of selected retrieval schemes: experimental methods for developing indexing systems and analyzing subject content.

323. On-Line Retrieval Systems (3)
Current major document retrieval systems and services: structure, content, effectiveness, and cost. Practical experience and experiment. Kasarda

324. (Psych 324) Life-Span Development of Information Processing Abilities (3)
Perception, storage, retrieval, use and communication of information as these abilities change from infancy to old age.

333. Automated Language Processing for Document Retrieval (3)
Document and passage retrieval. Basic ideas, operations and experiments to date, problems and possibilities. Computer and person-computer performance: retrieval by search of natural language text of unindexed documents; retrieval of answer-passages in documents; generation of thesauri; indexing, classifying, and abstracting. O'Connor

342. Artificial Intelligence (3) spring
Concepts and examples of artificial intelligence. Exercises to be programmed in LISP. Prerequisite: 362 or approval of the division head. Rayna

343. (EdT 343) Microcomputer-Aided Instruction (3)
Design and development of microcomputer-assisted instructional units. Students design, program and test microcomputer-aided instructional units as drill, practice, tutorial, and simulation exercises.

351. (EdT 351) Cognitive Sceince (3)
A synthesis of elements of artificial intelligence, psychology and linguistics; concerned with models of the acquisition, representation, storage, retrieval and application of knowledge.

361. Automata and Formal Grammars (3)
Study of the interaction between recognition devices and generation devices for formal languages. Comparison of automata and formal grammars of differing strength. Application to questions of computability and decidability. Barnes

362. Programming Languages (3) fall and spring
Use, structure and implementation of several programming languages. Prerequisite: CIS 102 or CIS 203. Rayna

372. Readings and Project I (3)
Supervised independent work.

372. Readings and Project II (3)
Supervised independent work on a major project.

374. Information Retrieval Theory (3)
An introduction to the problems of computerized information storage and retrieval systems. Special attention is given to the logical and mathematical techniques for automatic text-processing, file generation, and inquiry negotiation.

390. Special Topics (1-3) offered as required
An opportunity for advanced work through supervised reading and research. Prerequisite: consent of the division head. May be repeated for credit.

402. (Psych 448) Seminar in Psycholinguistics (3)
Selected topics in psycholinguistics examined in depth and in detail. Prerequisite: CIS 310. Rubenstein

411. Advanced Programming Techniques (3) spring
Deeper study of structured programming, data structures, back-tracking, recursion. Applications of basic concepts of automata theory and formal language theory. Fundamental principles of "large program" design. Several major programming assignments using Pascal. Prerequisite: CIS 12 or 17 or consent of the division head. Gulden

422. Analysis of Information Systems (3)
The study of the organization of information systems with respect to design criteria, information acquisition and entry, information processing, classification and storage, retrieval and dissemination, feedback control and evaluation; operational requirements such as hardware, software and personnel, and system economics. Kasarda

431. Subject Document Retrieval (3)
Techniques and systems for retrieval of documents in response to subject requests. Request negotiation techniques, document indexing (coordinate, relational, weighted), Boolean and weighted-term searching methods, thesauri and classifications as aids to negotiation, indexing and searching, on-line retrieval, and citation indexes. O'Connor

433. (ECE 403) Design of Operating Systems (3)
Principles of operating systems with emphasis on hardware and software requirements and design methodologies for multi-programming systems. Global topics include the related areas of process management, resource management, and file systems. Prerequisite: ECE 315 or equivalent.

450. Information Network Theory (3) offered as required
Applications of graph theory to the modeling, simulation, and design of information networks. Prerequisite: CIS 374.

462. Retrieval Languages (3) offered as required
The study of formal indexing and retrieval languages, with special attention to the interaction between syntactic structure and retrieval properties. Examples are drawn from actual and experimental systems to show the effect of syntactic structure upon system capabilities. Barnes

466. Topics in the Theory of Automata and Formal Grammars (3) offered as required
Advanced study of automata-theoretic approaches to questions of computability, decidability, acceptability, and generability. May be repeated for credit. Prerequisite: CIS 361 or consent of the division head. Barnes

492. Special Topics (3)
Topics in the computing and information sciences not treated in other courses.

494. Information, Communication and Culture (3) offered as required
Human communication as a process of exchanging information, as a shaper of the culture, and their mutual interaction. Syntactics, semantics, and pragmatics as theoretical approaches to the study of communication and information.

Graduate Programs

On the graduate level, both master of science and doctor of philosophy programs are offered. These programs aim at providing practitioners in computing and information science with the strong conceptual background necessary to keep pace with rapid changes in the field. Each program provides a base of both theory and application, with emphasis on fundamentals rather than simply on techniques.

Basic to both programs is the concept that research and instruction reinforce each other. Consequently, whenever possible, students are expected to participate in research activities.

The graduate program is based on a bachelor's degree in computing science or information science. Students with other backgrounds may be admitted, but may have to take a number of courses without graduate credit to complete their preparation.

Maximum advantage is taken of courses in other departments. Consequently a student's program is a combination of courses in computing and information science, together with offerings by the departments of electrical and computer engineering, industrial engineering, mathematics, psychology, social relations, and others.

A candidate for the M.S. completes at least twenty-seven credit hours of approved course work and submits a thesis. Each student's schedule is chosen in consultation with the head of the division. Student schedules are planned on an individual basis to fit previous academic experience and career goals. Depending upon the candidate's background and interests, emphasis can be either in theoretical or applied directions.

A candidate for the Ph.D. submits a general plan to the division head at the beginning of the first year of doctoral studies. This plan must be approved by the candidate's special committee at the time of admission to candidacy.

The doctoral program in computing and information science is based on the candidate's approved plan of original and specialized research. A program of courses and seminars at the 400 level is formulated in the field in which the dissertation will be written.

Economics

Professors. Eli Schwartz, Ph.D., MacFarlane Professor, *chairperson;* J. Richard Aronson, Ph.D.; Nicholas W. Balabkins, Ph.D.; Alvin Cohen, Ph.D.; Gerald Garb, Ph.D.; John R. McNamara, Ph.D.; Robert J. Thornton, Ph.D.
Associate professors. John L. Hilley, Ph.D.; Thomas J. Hyclak, Ph.D.; Jon T. Innes, Ph.D.; John D. Keefe, M.A.; Arthur E. King, Ph.D.; R. Allen Moran, Ph.D.; Warren A. Pillsbury, Ph.D.; Ching Sheng Shen, Ph.D.
Assistant professors. William T. Alpert, Ph.D.; Laurence G. Kantor, Ph.D.; Vincent Munley, Ph.D.
Adjunct professor. Finn B. Jensen, Ph.D.

Though economics is variously defined, modern-day definitions generally suggest that it is the study of the principles that govern the efficient allocation of resources.

One of the greatest of the 19th Century economists who did much to uncover these principles suggested a broader definition. Alfred Marshall described economics as "a study of mankind in the ordinary business of life...a part of the study of man." This dual natural of economics, technical and humanistic, is reflected in the fact that at Lehigh, the economics major is available to students in the College of Arts and Science as well as in the College of Business and Economics.

As the description below suggests, the economics program is exceptionally flexible once one moves beyond the sophomore year. This flexibility allows the major to be adapted easily to the needs of students with widely varying goals. Although many students choose the economics major in order to secure a firm foundation in economics and finance before entering the business world, many others choose it as preparation for law school or as a complement to their major in government, history, international relations, journalism, mathematics or urban studies. Naturally, many students who major in economics do so with the intent of pursuing graduate work at the master of business administration or doctor of philosophy level; others simply want to become "economically literate" in a world where such literacy is increasingly in demand.

At the same time that the program provides flexibility, it also consists of a substantial core of economic theory and related courses. This assures that the student who is uncertain concerning career goals will obtain a broad education in economics and business no matter what upper-level courses are chosen.

Students who are interested in designing a major program in economics suitable to their needs should consult with the curriculum director or department chairperson.

Major in Arts and Science

freshman year

Eco 1	Economics (4)
Math 41 and 44*	BMSS Calculus (6)

*Students who wish to take mathematics beyond calculus should substitute Math 21, 22, and 23 for this requirement.

sophomore year

Acctg 51	Essentials of Accounting (3)
Eco 145	Statistical Methods (3)
Eco 105	Microeconomic Analysis (3)
Eco 119	Macroeconomic Analysis (3)

junior year

Fin 225	Business Finance (3)
Eco 229	Money and Banking (3)
Eco electives*	any 300-level economics courses (6)

senior year

Eco electives*	any 300-level economics courses (9)

*Upper-level finance courses may substituted for economics courses with the approval of the curriculum director.

Major in Business and Economics

Fifteen credit hours in economics beyond the core listed on page are required.

Undergraduate Courses In Economics

1. Economics (4) fall-spring
A course in the principles of economics. General topics covered are: the determination of national income; the determination of relative prices; money and banking; monetary and fiscal policy; and government finance. Eco 1 is a prerequisite for all subsequent courses in economics.

101. (Mgt 101) Introduction to Quantitative Methods (3)
Mathematical concepts within a business and economics framework: linear algebra, partial derivatives, constrained optimization, and integral calculus. Meets mathematics prerequisite for entering students in the master of business administration program. Not available for credit to undergraduates in the College of Business and Economics.

105. Microeconomic Analysis (3) fall-spring
Determination of prices in terms of the equilibrium of the business enterprise and consumer choice in markets of varying degrees of competition; determination of wages, rent, interest and profits.

119. Macroeconomic Analysis (3) fall-spring
An introduction to macroeconomic measurement, theory, and policy. Provides a framework within which broad macroeconomic policy prescriptions can be formulated especially with reference to such problems as inflation and unemployment.

145. Statistical Methods (3) fall-spring
Descriptive statistics, elementary probability and probability distributions, sampling, estimation of population parameters, decision theory, regression and correlation, analysis of variance, nonparametric tests, time series analysis, and index numbers.

For Advanced Undergraduates And Graduate Students

229. Money and Banking (3) fall-spring
A general course dealing with the nature and functions of money and commercial banking, monetary and banking development in the United States, the behavior of interest rates and the money market, the value of money, and monetary and fiscal policies.

300. Apprentice Teaching in Economics (1-3)
See the introductory pages of this section.

303. Economic Development (3) fall
The principal determinants of economic development theories are examined. Although most of the theories are applicable to both the advanced industrial societies and to the poorer nations, the emphasis is on the developmental process of the countries of the Third World. Cohen

305. The Economic Development of Latin America (3) spring
The course examines the forces at work in the development process in Latin America. Given the holistic nature of this process, the variables which are considered include the social and the political as well as the economic ones. Theories are presented along with their application via the examination of country case studies. Cohen

309. Comparative Economic Systems (3) fall
An analysis of the economic, institutional, and political dimensions of non-market economies in the Soviet Union and China. Balabkins

310. Economic Evolution (3) spring, odd-numbered years
Structural changes, social transformation, and sources of the long-term growth of the U.S. economy. Balabkins, Thornton

311. Environmental Economics (3) fall
Economic policies for environmental protection. The optimal development of natural resources. The relationship between economic growth and environmental degradation. Case studies in water-quality management. McNamara

312. Urban Economics (3) spring
A survey and analysis of economic problems related to urban areas; the nature and function of cities; the economic and spatial characteristics of urban activity including housing, land value, land use, transportation, fiscal problems, urban labor markets, and poverty. Pillsbury

313. History of Economic Thought (3) fall, even-numbered years
Chronological survey and critical evaluation of the evolution of economic science. Analysis of the contributions of the Classical, Marginalist, Neo-classical, Keynesian, Institutionalist, and Structuralist schools. Cohen

314. Energy Economics (3) spring
The economic theory of resource allocation over time. Economics of exhaustible and renewable natural resources. Energy production, transportation, pricing and consumption. Government regulation of the energy industry. Computer models for energy system forecasting and planning. McNamara

315. Industrial Organization (3) spring
Structure of American industry and economic forces that influence it. Development of economic models to describe behavior in markets with varying degrees of competition. Technological innovation, market structure, relationship between industry concentration and rates of return on capital, role of information and advertisting, dynamics of monopoly and oligopoly pricing, and implications of mergers. Prerequisite: Eco 105. Garb or Kantor

320. Advanced Macroeconomic Analysis (3) spring, even-numbered years
A further course in macroeconomic theory and policy. Primary consideration is given to alternative theoretical specifications of monetary economies and the resulting policy implications for achieving economic growth and stability. Prerequisite: Eco 119 or equivalent. Innes

332. (Fin 332) Monetary-Fiscal Policy (3) spring
A course devoted to the study of monetary, credit and fiscal policies of governments and central banks with particular reference to the policies of the United States Treasury and the Federal Reserve System. Current problems receive emphasis. Prerequisite: Eco 119 or equivalent. Schwartz or Kantor

333. Managerial Economics (3) spring
The fundamental business disciplines are integrated through the development of a model of managerial decision making. Emphasis on the application of economic theory to a variety of business problems. Consideration is given to problems involving risk and uncertainty. Case studies are employed as illustrative examples. Moran

335. Labor Economics (3) spring
The economic analysis of labor markets, with emphasis on labor supply and demand, wage and employment theory, and the economics of unionism and certain other labor market institutions. Thornton, Hyclak

336. Business and Government (3) fall, odd-numbered years
An economic analysis of government involvement in the private sector. The problems of monopoly, oligarchy, and externalities in production and consumption are examined. Theory is used to develop optimum responses to market failure and to analyze the performance of actual government policies. Prerequisite: Eco 105. Munley or Pillsbury

337. Transportation and Spatial Economics (3) spring, even-numbered years
The principles of transportation in theory and practice are integrated with traditional and spatial economics. Transport models and location theories are reviewed for varying conditions of spatial separation of economic activity. Transportation policies are analyzed and evaluated in terms of their efficiency in the allocation of resources for the firm and the economy at the local, regional, and national levels. Prerequisite: Eco 105 or consent of the department chairperson. Pillsbury

338. Labor Market Institutions (3) fall
The development of the social and legal status of trade unions; the process of collective bargaining; the evolution of modern social welfare programs. Hyclak, Thornton

339. International Trade (3) fall
The theory of international trade; the theory of tariffs; United States commercial policies; the impact of growth and development of the world economy. Hilley or Jensen

340. (Fin 340) International Finance (3) spring
The balance of payments and the theory of disturbances and adjustment in the international economy; international monetary policies. Prerequisite: Eco 229. Hilley

343. European Economic Integration (3) spring, odd-numbered years
Analysis of the problems of economic integration with special emphasis on the development of economic cooperation and integration in Western Europe. The methods and the problems of economic planning in the Common Market. United States trade and investments, and European economic integration. Jensen

346. Business Cycles and Forecasting (3) fall, odd-numbered years
A study of economic conditions, involving short-term fluctuations, growth, forecasting and stabilization proposals. Prerequisite: a course in statistics. Shen

348. Advanced Business Cycles (3)
Recent business cycle theories, the evolution of the theories and the problems of economic change that the theories attempt to explain. Prerequisite: Eco 346. Students desiring this course should consult the department chairperson. Shen

351. Introduction to Mathematical Economics (3) fall, even-numbered years
Applies mathematical techniques to economic problems of optimization and constrained optimization and to economic models involving both comparative static and dynamic analysis. Prerequisites: Math 41 and 44, Eco 105 and 119. Innes

352. Advanced Statistical Methods (3) spring
Advanced treatment of probability theory, probability distributions, sampling and sampling distribution, and classical statistical inference. Construction of index numbers. Multiple regression and correlation and the analysis of variance. Special analysis, Box-Jenkin's auto-regressive and moving average stochastic processes. Shen

353. (Fin 353) Public Finance: Federal (3) fall
A course dealing with government expenditures and revenues, the economics of taxation, and government administration. Aronson or Munley

354. (Fin 354) Public Finance: State and Local (3) spring, odd-numbered years
The major issues regarding revenues, expenditures, debt

and budgeting policy are examined in the light of fiscal principles and economic effects of state and local governments. Special attention is placed on intergovernmental fiscal relations. Aronson or Munley

357. Applied Econometrics for Business and Economics (3) fall
This course provides empirical content to concepts developed in intermediate economic theory. Applied problems in construction, evaluation and use of econometric models are included. The student has the opportunity to gain practical experience through research and case studies. Prerequisites: a course in statistics and a course in intermediate economic theory. King

371. Readings in Economics (3)
Readings in various fields of economics, designed for the student who has a special interest in some field of economics not covered by the regularly rostered courses. Prerequisite: preparation in economics acceptable to the department chairperson.

372. Readings in Economics (3)
Continuation of Eco 371.

For Graduate Students

401. Basic Statistics for Business and Economics (3)
Descriptive statistics, probability and probability distributions, estimation, hypothesis testing, regression, chi-square, and analysis of variance. Computer applications.

405. Microeconomic Theory (3)
The role of the price mechanism in the allocation of scarce resources among competing uses. Emphasis is placed on the behavior of consumers and firms in various market structures. Attention is given to the pricing of the factors of production, as well as to the analysis of general equilibrium.

409. Money, Banking, and Macroeconomic Analysis (3)
The monetary process and the determination of macroeconomic variables: income, output, employment, and prices. Money and capital markets, interest rates, functions of financial intermediaries, monetary and fiscal policy, and recent macroeconomic issues. Kantor or Schwartz

421. Managerial Economics (3)
Application of economic analysis to business problems: price and output determination, analysis of cost and demand functions in various markets, and forecasting business conditions. Case studies. Prerequisites: Eco 405 and Mgt 401. Innes or McNamara

432. Advanced Microeconomic Analysis (3) fall
A survey of methods of decision-making at the microeconomic level utilizing concepts developed in price theory and econometrics. Prerequisite: Eco 105 or equivalent. Garb, Hilley

433. (Fin 433) Valuation Seminar (3) fall
Determinants of financial asset values. The role of uncertainty, imprecise forecasts, risk preferences, inflation, and market conditions. Prerequisite: Fin 411. Beidleman, Buell

435. Advanced Topics in Microeconomics (3) spring, odd-numbered years
Topics in resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under monopoly, monopsony, competition, and alternative market forms. Prerequisites: Eco 105 and 145 or equivalents. Garb

436. Advanced Topics in Macroeconomics (3) spring, odd-numbered years
Theory of employment, income, and growth. Role of money in theory of output. Policies for economic stability and growth. Prerequisite: consent of the department chairperson. Innes

437. Labor Economics (3) fall
The economics of labor markets and various labor market institutions with emphasis on current theoretical and empirical research. Prerequisites: intermediate microeconomics and statistics. Hyclak or Thornton

438. Labor-Management Administration (3) spring
A study of the U.S. system of industrial relations, including the evolution and present status of labor law; union organizing efforts; the strategy of negotiations; the substantive provisions of collective bargaining agreements; and the administration of collective agreements through the grievance procedure and arbitration. The system of industrial relations and public policy toward industrial relations are subjected to critical appraisal. Hyclak or Thornton

439. History of Economic Thought (3) spring, odd-numbered years
Consideration of selected topics in the history of economic thought, with special attention devoted to tracing the origins of modern economic theory. Prerequisite: graduate exposure to economic theory. Cohen

440. Regional Science-Metropolitan Analysis (3) fall, even-numbered years
A study of the methodology of regional science with emphasis on metropolitan area analysis. A survey of the applications of this methodology to the economic problems of regions and metropolitan areas. Pillsbury

442. (Fin 442) Foreign Trade Management (3) spring, odd-numbered years
Foreign operations, including export channels in foreign markets, export and import financing, foreign investments, and policies of government and international agencies as they affect foreign operations.

443. Economics of Environmental Management (3) fall, even-numbered years
The economic theory of natural resources. Optimal policies for the development of renewable and nonrenewable resources, environmental quality management systems. Prerequisites: Eco 105 or equivalent and Math 44 or equivalent. McNamara

444. (Fin 444) Banking and Monetary Policy (3) fall-spring
Description and analysis of the U.S. monetary and banking structure. The supply of, and demand for funds. Financial markets. Central bank controls, monetary theory and policy. Prerequisite: a course in money and banking. Innes, Kantor, or Schwartz

445. International Economics Theory (3)
The theory of international economics, with emphasis on the way in which general economic theory is applied to the problems and issues of international economics. Prerequisite: consent of the department chairperson. Students desiring this course should consult the chairperson. Garb or Hilley

447. (Fin 447) Capital and Interest Theory (3) fall, alternate years
Examination of theories of interest and capital. The following topics are investigated; annuities, applications of present value theory; investment valuation under certainty and risk; term structure of interest rates; the theory of savings, cost of capital and capital formation. Prerequisite: basic economics and finance. Schwartz

449. Public Finance (3) spring, even-numbered years
Major issues in taxation of income, consumption, and capital; principles of government debt management; budgeting and fiscal planning for economic stability and growth. Aronson, Munley

451. Development Theory and Problems (3) fall, even-numbered years
The evolution of growth doctrines and the analysis of such developmental problems as structural versus monetary reform, ideological controversy on the appropriate economic system, balanced investment programs as opposed to unbalanced plans, the nature of and changes in the aggregate production function, and dependence upon domestic as opposed to foreign sources of savings. Prerequisite: Eco 303. Cohen

453. Index Numbers and Time Series Analysis (3)
Classical decomposition of time series into irregular, seasonal, cyclical, and trend components. Criteria for good deseasonalization and Census XII methods. Trend analysis including growth curve fitting, orthogonal polynomial, learning curve. Club of Rome Method, etc. Emphasis on exponential smoothing, spectral analysis, and Box-Jenkins autoregressive and moving average methods. Shen

454. Forecasting (3) spring, even-numbered years
Review of business cycle analysis. A study of the methods of economic and business forecasting including NBER leading indicator forecasting anticipation and planned expenditure survey methods, judgmental forecasting (GNP decomposition), input-output forecasting, econometric forecasting and time series forecasting. Distinction between short-run and long-run forecasting. Delphi Method on technological forecasting, sales forecasting and others are introduced. Shen

455. Econometric Methods (3) spring, odd-numbered years
Mathematical and statistical specification of economic and business models. Statistical estimation and test of economic and business parameters in single and multiple equation models. Prediction and test of structural changes. Prerequisites: background in statistics and calculus. Shen

456. Mathematical Economics (3) fall, odd-numbered years
Designed to provide an understanding of the way in which various mathematical techniques are applied in the formulation and development of economic concepts and theories. The course may draw on theories of the consumer and of the firm, the analysis of economic fluctuations and growth, general equilibrium theory, and other areas of economics where mathematical techniques have been found to be useful. Prerequisite: consent of the department chairperson. Garb

457. (Fin 457) Monetary Theory (3)
An advanced course that examines the role of money in the economy from a theoretical as well as an empirical prespective. The influence of money on prices, interest rates, output and employment is analyzed using models of closed and open economies. Prerequisite: Eco/Fin 444 or equivalent. Innes or Hilley

459. (Fin 459) International Financial Economics (3)
Analysis of the structure and functioning of the international monetary system, international capital markets, Eurocurrency markets, fixed and floating exchange rates, and the role of international monetary institutions in foreign exchange risk management. Hilley

461. Methodology in Theory and Research (3)
Foundations of theory construction and empirical research in economics and related subject matter. Theory, hypothesis formation and empirical study in the business firm, organizations, industrial relations, and micro-macro research. Students desiring this course should consult the department chairperson. Balabkins or Garb

471. Special Topics in Economics (3)
An extended study of an approved topic in the field of economics.

472. Special Topics (3)
Selected topics not covered in scheduled courses in the department. May be repeated for credit with consent of the department chairperson.

490. Thesis in Economics (6)
Subjects for thesis may be selected by consultation with the major adviser and approval of the department chairperson and master of arts committee.

School of Education

Perry A. Zirkel, *dean.*

The School of Education is organized into three departments: Administration and Supervision (AdmS), Human Development (HD), and Instruction and Curriculum (I&C). Faculty and course offerings are listed by department.

Course listings for the interdepartmental program in educational technology (EdT) are listed after those for the three departments. The reader is also referred to the entries in Section IV for the School of Education and for Interdisciplinary Study in Graduate Programs.

Department of Administration and Supervision

Professors. Charles W. Guditus, Ed.D., *chairperson;* Perry A. Zirkel, J.D., Ph.D., *dean;* LeRoy J. Tuscher, Ph.D.
Assistant professors. Robert D. Fleischer, Ed.D.; Stinson W. Stroup, J.D.
Adjunct professors. Robert J. Kopecek, Ed.D.; Donald Langlois, Ed.D.; Thomas E. Persing, Ed.D.; Margaret A. Smith, D.Ed.; Stephen Sivulich, Ed.D.

AdmS 328. (Govt 328) The Politics of Urban Education Policy (3)
The interplay of political forces in selected urban policy areas. Readings, lectures, and a class simulation to concentrate on the roots of urban poverty; school desegregation, community control, fiscal reform, and the political role of community groups, government agencies, the courts, and social science.

For Graduate Students

AdmS 400. Educational Administration: Theory and Practice (3)
Development of theories of administration and applications in educational institutions. Administrative behavior in organizational settings; administrator's leadership role in decision-making, evaluation, and conflict resolution.

AdmS 402. Elementary School Administration (3)
Major problems of organization and administration of elementary schools; types of organization, pupil promotion, time allotment, service agencies, and plant equipment.

AdmS 403. (HD 403, I&C 403) Research (3)
Basic principles of research; techniques of gathering and analyzing data; design of studies in education. Emphasis on critical reviews of research reports representing various methodologies. Research report required.

AdmS 404. Secondary School Administration (3)
Major problems of organization and administration of secondary schools; program of studies, teaching staff, pupil personnel, plant and equipment, and community relationships.

AdmS 406. School Principals Clinic (3-6)
Simulated materials workshop on administrative decision-making open to practicing and prospective elementary and secondary school administrators.

AdmS 410. Administration of Higher Education (3)
Analysis of legal foundations, administrative controls, and operational patterns of various types of institutions of higher education.

AdmS 450. (I&C 450) Foundations of Curriculum Construction (3)
Principles of organization of program of studies for elementary and secondary schools; origin and background of the curriculum; methods of organization; curriculum planning and development; pertinent applications. Kindergarten through 12th grade (K-12).

AdmS 452. (I&C 452) The Elementary School Curriculum (3)
Problems of curriculum development in the first six grades; subject matter placement, program making for difficult types of schools, regular vs. special subjects, articulation.

AdmS 454. (I&C 454) The Secondary School Curriculum (3)
Methods of study of curriculum problems, selection of subject matter in various fields, principles of program construction, and similar problems.

AdmS 466. Supervision of Instruction (3)
Analysis of the principles underlying the organization and supervision of instruction; application to specific teaching situations. K-12

AdmS 467. (I&C 467) Management Seminar for Supervisors (3)
A seminar on organization and management for first-line instructional supervisors. Covers four areas, including the legal aspects of supervision, budget development, evaluation, and organization behavior.

AdmS 469. (I&C 469) Advanced Instructional Supervision (3)
A staff development approach to supervision designed to extend the supervisor's knowledge of and skills in applying clinical techniques to instructional supervision.

AdmS 471. Women in Educational Administration (3)
An analysis of the inherent problems and current status of women in educational administration. An affirmative approach to the development of career action plans.

AdmS 473. Personnel Administration (3)
Overview of the personnel function in educational institutions. Trends in staff planning, recruitment, selection, assignment, and orientation, as well as tenure, grievances and related matters.

AdmS 474. Planning for Facility Use (3)
Focus on long-range planning with emphasis on data collection and analysis involved in closing, modifying and/or establishing alternative uses for school facilities. Simulations and field applications are provided.

AdmS 475. Education Resources Management (3)
Systems designed to support educational decision-making. Analysis of conceptual design for planning-programming-budgeting and evaluation systems.

AdmS 476. School Finance (3)
Concepts of school finance including intergovernmental fiscal relations, state grants-in-aid, taxation, municipal borrowing, and long-term capital outlay programs.

AdmS 477. Seminar in School-Community Relations (3)
Analysis and development of the communication and public relations skills needed by educators in dealing with the public.

AdmS 478. Collective Bargaining in the Schools (3)
Contract negotiations, grievance, mediation, and arbitration for both professional and classified employees in education.

AdmS 479. School Law (3)
Effect of school law on administration of public school systems; analysis and synthesis of judicial interpretations of the constitutions, statutes, rules, regulations, and common law relating to educational issues.

AdmS 480. Administration of Student Service in Higher Education (3)
Administration of student services in higher education including welfare, control, activities, and teaching functions. Organization and operation; administrator's role in development and implementation of appropriate policies.

AdmS 481. Policy and Politics in Public Education (3)
Analysis of the forces, factors, agencies, formal governmental systems and informal subsystems that influence educational policy in local districts and state and national governments.

AdmS 491-2. (I&C 491) Advanced Seminars in Education: (with subtitle) (1-3)
Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

AdmS 493. (HD 493, I&C 493) Internship (3-9)
Opportunity for advanced students to obtain practical experience. Conference hours for students and staff members devoted to discussion of work and problems encountered in the schools. Prerequisite: consent of the program director.

AdmS 494. (HD 494, I&C 494) Field Work (3)
Identification of significant problems in an educational environment, review of the literature, and development of research plans.

AdmS 495. (HD 495, I&C 495) Independent Study and Research (1-6)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated for credit.

AdmS 496. (HD 496, I&C 496) Seminar in Research (3)
For doctoral students. Research design and application to various kinds of educational problems; data collection and anlaysis. Criticism and evaluation of student proposals. May be repeated for a maximum of nine credits.

Department of Human Development

Professors. Raymond Bell, Ed.D., *chairperson;* Andrew J. Edmiston, Ph.D.; Joseph P. Kender, Ed.D.; J. Gary Lutz, Ed.D.; John A. Mierzwa, Ed.D.; Paul VanR. Miller, Ph.D.; Herbert Rubenstein, Ph.D.
Associate professors. Warren R. Heydenberk, Ed.D.; Artis J. Palmo, Ed.D.; William B. Stafford, Ed.D.
Assistant professor. Francis E. Lentz, Ph.D.

Adjunct associate professor. Mervin P. Smolinsky, Ph.D.
Adjunct assistant professors. Ronald J. Esteve, Ph.D.; John C. Turoczi, Ed.D.

The department of human development is one of three departments in the graduate School of Education. The department brings together those faculty and programs in counseling, measurements and research, reading, social restoration, and school psychology that provide specialized services for individuals in schools, colleges, and other social institutions.

The department and its programs are purposefully small in keeping with the tradition of private higher education. The atmosphere is informal, and close, personal interaction between faculty members and students is fostered.

For Advanced Undergraduates and Graduate Students

HD 320. (Psych 320) Psycholinguistics (3)
Study of the experimental and observational literature on psychological processes involved in the production, comprehension and use of language by adults.

HD 324. (Psych 324) Lifespan Cognitive Development (3)
Changes in perception, learning, memory, and problem solving from infancy to old age.

HD 330. Study of the Individual (3-6)
Examinations of individual growth and development, especially the patterns found in different subcultures. Prerequisite: consent of the program director.

HD 341. The Teacher in Social Restoration (3-6)
Functions of the teacher and the school in prevention and remediation of antisocial behavior. Field work in remedial teaching and experience in social restoration institutions. For social restoration interns only.

HD 343. The Disadvantaged Student (3)
Philosophical analyses of disadvantagement and relevant educational theories. Applications and evaluations of special methods and techniques.

HD 351. Statistical Methods in Research (3)
Methods of describing and condensing sample data and drawing inferences about population characteristics. No background in statistics presumed. Emphasis on concepts.

HD 371. (Psych 371) Learning (3) spring
Principles of learning with emphasis on reinforcement, discrimination, motivation, verbal learning and memory. Critical evaluation of classical and contemporary theories of learning. Prerequisite: Psych 1.

HD 388. (Math 388) Computer Applications (3)
Writing and testing computer programs; use and adaptation of packaged programs; applications in behavorial research, administration, and instruction. Prerequisite: HD 407 or HD 408, or consent of the program director.

For Graduate Students

HD 400. Psychological Foundations of Education (3)
Psychological study of student development and the classroom environment.

HD 402. (Psych 402) Behavior Modification (3)
Theory and application of behavior modification methods in classroom and clinical settings. Methods derived from operant, classical, and cognitive models. Topics include behavior analysis, charting behaviors, outcome research, and ethical and philosophical issues. Prerequisite: HD 400 or its equivalent.

HD 403. (AdmS 403, I&C 403) Research (3)
Basic principles of research; techniques of gathering and analyzing data; design of studies in education. Emphasis on critical reviews of research reports representing various methodologies. Research report required.

HD 404. (I&C 404) Introduction to Testing and Evaluation (3)
Construction and evaluation of the teacher-made test. Selection of published tests and interpretation of individual and group results. Use and misuse of tests in assessing achievement.

HD 405. (I&C 405) Assessment of Exceptional Individuals (3)
Pyschological and educational assessment procedures used with exceptional individuals. Understanding and applying information from psychological testing and utilizing formal education assessment and interviews.

HD 406. Standardized Tests and Measurements (3)
Principles of psychological measurements utilizing assessment techniques with focus upon standard group and individual tests. Administration and interpretation of tests. Prerequisite: HD 404 (I&C 404).

HD 407. Methods of Statistical Inference and Research Design (3)
Introduction to packaged programs for computer analysis. Analysis of variance and covariance in experimental designs. Multiple correlation and regression. Prerequisite: HD 351 or consent of the program director.

HD 408. Statistics I (3)
Data reduction, characteristics of frequency distributions, bivariate correlation and regression. Hypothesis testing, interval estimation, errors of inference, statistical power. Normal, t, F, and chi-square sampling distributions.

HD 409. Statistics II (3)
One-way and factorial analysis of variance and covariance. Multiple correlation and regression, partial and part correlation. Use of packaged programs for computer analysis. Prerequisite: HD 408 or consent of the program director.

HD 410. Statistics III (3)
Analysis of variance and covariance in higher-order experimental designs including factorial, incomplete factorial, nested, and repeated measures. Linear models approach. Prerequisite: consent of the program director.

HD 411. Multivariate Analysis (3)
Multinormal sampling distribution. Multivariate tests of significance, interval estimation, analysis of variance and covariance. Discriminant analysis, canonical correlation, introduction to factor analysis. Prerequisite: HD 410 or consent of the program director.

HD 412. Psychometric Theory (3)
Theory of measurement applied to various kinds of tests and scales. Item analysis; pretesting, scaling and equating; errors of measurement; reliability and validity; prediction. Prerequisite: HD 351 or 408 or consent of the program director.

HD 413. (I&C 413) Intern Teaching (3-6)
Intensive practice in the application of principles of teaching. Supervision is provided by the cooperating school and by the university. Prerequisite: consent of the program director.

HD 414. (I&C 414) Intern Teaching Seminar (3)
Critical analysis and discussion of classroom instructional

practices. Discussion and illustration based on experiences of participants as they engage in intern teaching. Prerequisite: consent of the program director.

HD 420. Linguistics in Education (3)
The nature of language, phonetic applications and the relationships of linguistics to instruction in the language arts.

HD 421. Materials in Reading (3)
Provides examination and critical analysis of published and unpublished reading materials used in instruction from kindergarten through adult levels. Prerequisite: HD 426 or consent of the program director.

HD 422. (I&C 422) Language Development of Children (3)
The nature of language and its relation to the development of communication skills. Critical analysis of related research. Implications for the elementary school.

HD 424. Development Reading (3)
Introductory course spanning the elementary and secondary levels. Reading methods, materials, the disadvantaged and gifted reader, procedures for individualizing reading instruction. Field experience required.

HD 426. Diagnosis and Adjustment of Reading Difficulties (3)
Psychology of reading related to learning difficulties; measurement and diagnosis of reading difficulties; development of informal tests; materials for corrective and/or remedial instruction. Prerequisite: HD 424 or consent of the program director.

HD 427. (I&C 427) Children's Literature in Reading Instruction (3)
Role of literature in the instructional program of the elementary schools. Use of trade books for individual instruction in reading.

HD 428. Reading in the Content Areas (3)
Focuses on expository reading development in content areas such as language arts, mathematics, science and social studies. Practical teaching strategies in critical areas, such as comprehension and study skills. Review of research and methods for improving the reading development of students.

HD 430. Advanced Topics in Reading (3)
Theory and research in historical background of reading instruction; cognitive, affective, and linguistic aspects of reading; implications for the disadvantaged and gifted reader. Field experience required. Prerequisite: HD 424 or consent of the program director.

HD 432. Reading Specialists Clinic (3-12)

HD 434. Seminar in Reading Research (3)
An advanced course dealing with critical appraisal and discussion of classical and current studies in reading.

HD 436. Practicum in Supervision of Reading Program (3-6)
For candidates for supervisor's certificate in reading. Organization of the instructional program and duties involved in the supervisory processes in reading programs. Participation in supervisory activities.

HD 442. (I&C 442). Criteria- and Performance-Based Evaluation (3)
Measurement and evaluation theory and techniques with particular reference to criterion-based performance evaluation in vocational and career education.

HD 443. Advanced Counseling Clinic (6)
Supervised field experience in counseling settings for advanced students. May be repeated for credit.

HD 445. School Psychology Practicum (3-6)
Field experience in educational settings.

HD 446. School Psychology Internship (6)
Full-time experience in educational settings.

HD 451. Philosophy and Principles of Guidance (3)
Theoretical foundations, principles and ethics of guidance processes, functions, services and organization of an educational guidance program.

HD 453. Consultation Procedures (3)
Observational methodology utilized in consultation; rationale, theory and methods of consultation; individual, group and parent consulting. Study of research on the consultation process.

HD 455. Career Development (3)
Process of selecting and pursuing educational and vocational goals; emphasis upon decision-making. Evaluating and using occupational, educational and related information.

HD 457. Counseling in the Community (3)
Community agencies are examined through readings, lectures and student presentations. Field investigation of a community counseling agency. Professional ethics, legal issues, accountability and organizational structure of agencies.

HD 459. Elementary School Guidance (3)
Roles of counselors, teachers, parents, and other specialists and their influence upon the development of the child. Practical concerns emphasized. Prerequisites: HD 451 and consent of the program director.

HD 461. Secondary School Guidance (3)
Establishment of a secondary guidance program within the school. Practical approaches to involve students, teachers, administrators, and parents in the guidance activities of the school.

HD 463. Counseling (3)
Theories and techniques of counseling. Students will practice counseling skills. Prerequisites: admission to a counseling program and HD 451 or 457.

HD 465. Introduction to Group Processes (3)
Introduction to the process of group counseling and group guidance. Selection of group members; group rules; group procedures with children, adolescents and adults; ethical consideration of groups. Study of research on group processes.

HD 467. Biofeedback in Counseling (3)
Theory and practice in biofeedback techniques; experience in using biofeedback instruments. Special attention paid to relaxation procedures and anxiety reduction. Prerequisite: HD 463.

HD 469. Group Counseling and Group Processes (3)
Group processes as related to counseling and guidance through class participation and demonstration. Prerequisite: HD 463 previously or concurrently.

HD 471. (Psych 451) Theories of Learning (3)
In-depth study of major classical and contemporary learning theories. Review of experimental research relevant to theories.

HD 473. (Psych 473) Personality and Adjustment (3)
Theories of personality and adjustment with emphasis on the adjustment processes in an educational setting. Prerequisite: consent of the program director.

HD 474. (Psych 474) Special Topics in Development Psychology (3)
Topics selected from such areas as socialization and the parent-child interaction, personality disorders in childhood, moral development and cognitive development. May be repeated for credit.

HD 475. (Psych 475) Theories of Psychological Counseling (3)
Analysis and synthesis of concepts drawn from counseling theorists. Research and current trends in counseling concerning educational, social and vocational problems. Prerequisite: admission to the program in counseling.

HD 477. Current Issues in Counseling (3)
Examination of an area of counseling that is of topical interest to students and faculty. Permission of program director required. May be repeated for credit.

HD 481. Assessment in School Psychology (3-6)
Practice in the administration of individual tests and preparation of school psychological reports. Prerequisite: admission to the program in school psychology.

HD 483. Diagnostic and Remedial Procedures in School Psychology (3)
Components that comprise a psychoeducational evaluation. Childhood disorders are examined in relation to etiology, diagnostic criteria and appropriate intervention strategies. Integration of data from case histories, interviews and tests in making differential diagnoses. Prerequisite: HD 481.

HD 485. Seminar in School Psychology (3)
Role of the school psychologist, emphasis upon consultation. Legal aspects of school psychology. Prerequisite: admission to the school psychology program.

HD 491-2. Advanced Seminars in Human Development: (with subtitle) (1-3)
Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

HD 493. (AdmS 493, I&C 493) Internship (3-9)
Opportunity for advanced students to obtain practical experience. Conference hours for students and staff members devoted to discussion of work and problems encountered in the schools. Prerequisite: consent of the program director.

HD 494. (AdmS 494, I&C 494) Field Work (3-6)
Identification of significant problems in an educational environment, review of the literature, and development of appropriate research plans.

HD 495. (AdmS 495, I&C 495) Independent Study and Research (1-6)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated.

HD 496. (AdmS 496, I&C 496) Seminar in Research (3)
For doctoral students. Research design and application to various kinds of educational problems; data collection and analysis. Criticism and evaluation of student proposals. May be repeated for a maximum of nine credits.

Department of Instruction and Curriculum

Professors. Robert L. Leight, Ed.D., *chairperson;* Alfred J. Castaldi, Ed.D.; Norman H. Sam, Ed.D.
Associate professors. Alice D. Rinehart, Ed.D., Elvin G. Warfel, Ed.D.
Assistant professors. Diane Browder, Ph.D.; Robert J. Suppa, Ed.D.
Adjunct professor. Henry W. Ray, Ed.D., Merle Tate, Ed.D.
Adjunct associate professor. Wanda McDaniel, Ed.D.
Adjunct assistant professors. George Bonckemper, Ed.D.; Paul Johnson, Ed.D.; Sheila LaFrankie, Ed.D.; Joseph Mickley, Ed.D.; Ruth B. Parr, M.Ed.; Ruth Rusling, Ed.D.; Hillary Shuard, M.Sc.

For Advanced Undergraduates and Graduate Students

I&C 301. Origins of Western Schools (3-6)
Study and travel seminar for experienced teachers. Nature and methods of Hellenistic and medieval schools; relevant traditions in language, art and philosophy; influences on American institutions. Prerequisite: consent of the director of summer sessions.

I&C 312. Classroom Practice (1-3)
Experience in elementary and secondary classrooms as related to theories of child and adolescent development, classroom didactics, and philosophies of education. Problem-centered discussion and observations. Prerequisite: consent of the program director.

I&C 313. Intern Teaching (3-6)
Intensive practice in the application of the principles of teaching. Supervision is provided by the cooperating school and by the university. Prerequisite: consent of the program director.

I&C 314. Intern Seminar (1-3)
Critical analysis and discussion of classroom instructional practices based on experiences of participants as they engage in teaching experiences. Prerequisite: consent of the program director.

I&C 317. Instructional Media (3)
Principles underlying the use of graphics, and sound projection in teaching. Utilization of commercial, student, and teacher-made materials. Applications of new instructional media.

I&C 330. Special Topics in Special Education (1-3)
Special topics relating to the education of handicapped individuals. Titles vary (e.g., Survey of Special Education, Recreation Programs for Handicapped Adults, The Aging Handicapped Adult, Arts for the Handicapped). May be repeated for credit as title varies.

I&C 331. (Psych 352) Emotional and Behavioral Disorders (3)
Definition, classification, etiology, treatment, and historical perspective of individuals with emotional and behavioral disorders.

I&C 333. Mental Retardation (3)
Definition, classification, etiology, treatment, and historical perspective of individuals with mental retardation.

I&C 339. Learning Disabilities (3)
Definition, classification, etiology, treatment, and historical perspective of individuals with learning disabilities.

I&C 340. Special Topics in Vocational and Career Education: (with subtitle) (1-3)
Selected topics in vocational or career education of professional interest to faculty and students. Title varies. May be repeated for credit as title varies.

I&C 341. Career Education for the Handicapped (3)
Promoting attitudes, work habits, and skills which enhance employability of the handicapped; appraisal of methods for matching individuals to jobs; job market for the handicapped; various curricular and administrative designs.

I&C 343. Occupations and Manpower (3)
Nature of work in America. Structure of the workforce, Work values and attitudes. Sources of occupational information. Methods of surveying manpower needs. Manpower programs. Labor organizations. Relationships between educational systems and the work world.

I&C 391-2. Workshops (1-3)
Cooperative study of current educational problems. Provides elementary, secondary, and special education teachers an opportunity to work at their own teaching levels and in their own fields. Limited to six credits during a summer session but the student may register for more than one workshop provided there is no duplication in subject matter.

I&C 394. Special Topics in Instruction and Curriculum: (with subtitle) (3)
Examination of a topic of research or professional interest in curriculum or instruction. Title will vary (e.g., Youth in Society, Child Development, Introduction to Foundations of Education). May be repeated for credit.

For Graduate Students

I&C 401. Sociological Foundations of Education (3)
The American school as a social institution, its cultural heritage, its purposes and processes in relation to social change and educational leadership; its role in socialization and its responsibilities for relevance to social issues and to subcultural needs.

I&C 403. (AdmS 403, HD 403) Research (3)
Basic principles of research; techniques of gathering and analyzing data; design of studies in education. Emphasis on critical reviews of research reports representing various methodologies. Research report required.

I&C 404. (HD 404) Introduction to Testing and Evaluation (3)
Construction and evaluation of the teacher-made test. Selection of published tests and interpretation of individual and group results. Use and misuse of tests in assessing achievement.

I&C 405. (HD 405) Assessment of Exceptional Individuals (3)
Psychological and educational assessment procedures used with exceptional individuals. Understanding and applying information from psychological testing and utilizing formal education assessment and interviews.

I&C 406. Historical Foundations of Education (3)
Development of primary, secondary, and higher education; aims, curricula, methods, and systems of schooling in America from colonial time to present, in relation to social conditions.

I&C 407. Philosophical Foundations of Education (3)
Comparative philosophical analysis of educational aims, practices, and institutions. Major philosophical theorists whose work has influenced educational thought.

I&C 408. Comparative Education (3)
Survey of educational practices abroad from nursery to graduate education. Systems of articulation, social foundations, legal foundations, and structure in government. Nature and purposes of the schools with reference to cultural patterns. Focus upon major problems and trends.

I&C 409. Values and Educational Purpose (3)
Modes of philosophical analysis used in justification of educational purposes. Presence of metaphysical, epistemological, and metaethical premises in educational opinion. Manifestations of values in contemporary school curricula and educational decisions. Professional ethics.

I&C 410. Structure and Syntax of the Academic Disciplines (3)
Professors from other disciplines analyze patterns which organize and identify the academic disciplines; the nature and significance of conceptual structures which guide inquiry or research; implications for planning of curricula and preparations of teaching materials.

I&C 411. Classroom Didactics (3-6)
Initial preparation of interns for classroom teaching. Secondary interns are trained in teaching methods in subject fields and the reading problems of secondary students. Elementary interns study teaching methods in the elementary school. Open to teaching interns only.

I&C 412. Participation in Teaching (3)
Study, directed observation of, and initial practice in the various phases of teaching in a laboratory-demonstration school or in area elementary and secondary schools. Prerequisite: consent of the program director.

I&C 413. (HD 413) Intern Teaching (3-6)
Intensive practice in the application of principles of teaching. Supervision is provided by the cooperating school and by the university. Prerequisite: consent of the program director.

I&C 414. (HD 414) Intern Teaching Seminar (3)
Critical analysis and discussion of classroom instructional practices. Discussion and illustration based on experience of participants as they engage in intern teaching. Prerequisite: consent of the program director.

I&C 415. Motor Skills for Handicapped Children (3)
Normal sequential motor development in contrast to differential motor development of handicapped children. Instructional techniques.

I&C 416. Diagnostic and Prescriptive Teaching (3)
The role of the classroom teacher as an educational diagnostician. Emphasis on the nature and methods of informal educational diagnosis and specifics of prescriptive teaching in classrooms.

I&C 417. Language and Social Skills for Handicapped Children (3)
Atypical language and social development of handicapped children. Particular emphasis upon the development of and direct implementation of field programs.

I&C 418. Teaching Severely Multihandicapped Individuals (3)
Instructional emphasis upon areas of daily living and functional academics. Emphasis on training handicapped individuals to live in the least restrictive environment.

I&C 419. Teaching Mildly Handicapped Individuals (3)
Instructional emphasis upon specialized curricula and methods for teaching typical school subjects. Emphasis on training handicapped individuals to learn in the least restrictive environment.

I&C 421. Child Development (3)
A study of physical, intellectual, emotional and social aspects of child development as they relate to the elementary schools.

I&C 422. (HD 422) Language Development of Children (3)
The nature of language and its relation to the development of communication skills. Critical analysis of related research. Implications for the elementary school.

I&C 423. Social Studies in Elementary Education (3)

I&C 424. Science in Elementary Education (3)

I&C 425. Fine Arts in Elementary Education (3)

I&C 426. Mathematics in Elementary Education (3)

I&C 427. (HD 427) Children's Literature in Reading Instruction (3)
Role of literature in the instructional program of the elementary schools. Uses of trade books for individual instruction in reading.

I&C 430. Advanced Seminar in Special Education (1-3)
Advanced issues relating to the field of special education. Titles will vary (e.g., Managing the Environment of Severely Handicapped Individuals, Preschool Programs for Handicapped Children, Advanced Curricula and Methods, Severely/Multihandicapped Students). May be repeated for credit as title varies.

I&C 431. Education of Exceptional Children (3)
Curriculum, methods of instruction, and materials for individuals who differ markedly from the normal intellectually, physically, emotionally, or socially; the nature and causes of these differences; available resources. Field trips, direct work with exceptional children encouraged.

I&C 436. Development Learning Clinic (3)
Students with training in learning disabilities cooperate with school psychologists, reading specialists, and counselors in the assessment and formulation of prescriptive programs for children with special learning problems. Prerequisite: consent of the program director. May be repeated for credit.

I&C 438. Programs for Gifted and Talented (3)
Characteristics of gifted children; teaching gifted children; programs for the gifted in elementary and secondary schools.

I&C 441. Youth in Society (3)
Social development, characteristics, and problems of adolescents and young adults. Impact of relationships with siblings, peers, adults, subcultures, in the context of changing institutions and values.

I&C 442. (HD 442) Criteria- and Performance-Based Evaluation (3)
Measurement and evaluation theory and techniques with particular reference to criterion-based performance evaluation in vocational and career education.

I&C 450. (AdmS 450) Foundations of Curriculum Construction (3)
Principles of organization of programs of studies for elementary and secondary schools; origin and background of the curriculum; methods of organization; curriculum planning and development; pertinent applications. K-12.

I&C 452. (AdmS 452) The Elementary School Curriculum (3)
Problems of curriculum development in the first six grades; subject matter placement, program making for difficult types of schools, regular vs. special subjects, articulation.

I&C 454. (AdmS 454) The Secondary School Curriculum (3)
Methods of study of curriculum problems, selection of subject matter in various fields, principles of program construction, and similar problems.

I&C 467. (AdmS 467) Management Seminar for Supervision (3)
A seminar for organization and management for first-level supervision. Covers four areas, including the legal aspects of supervision, budget development, evaluation, and organizational behavior.

I&C 469. (AdmS 469) Advanced Instructional Supervision (3)
A staff development approach to supervision designed to extend the supervisor's knowledge of and skills in applying clinical techniques to instructional supervision.

I&C 491. (AdmS 491) Advanced Seminar in Education: (with subtitle) (3)
Intensive study and discussion of a specialized area. Title will vary. May be repeated for credit as title varies.

I&C 492. Advanced Seminar in Instruction and Curriculum: (with subtitle) (3)
Examination of an advanced topic in instruction or curriculum. Title will vary (e.g., Environmental Education, Teaching in Higher Education). May be repeated for credit as title varies.

I&C 493. (AdmS 493, HD 493) Internship (3-9)
Opportunity for advanced students to obtain practical experience. Conference hours for students and staff members devoted to discussion of work and problems encountered in the schools. Prerequisite: consent of the program director.

I&C 494. (AdmS 494, HD 494) Field Work (3)
Identification of significant problems in an educational environment, review of the literature, and development of appropriate research plans.

I&C 495. (AdmS 495, HD 495) Independent Study and Research (1-6)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated for credit.

I&C 496. (AdmS 496, HD 496) Seminar in Research (3)
For doctoral students. Research design and application to various kinds of educational problems; data collection and analysis. Criticism and evaluation of student proposals. May be repeated for a maximum of nine credits.

Educational Technology Program

EdT 311. (CIS 311) Foundations of Instructional Programming in BASIC (3)
The essential elements of programming methodology. Special emphasis on the BASIC language for microcomputers and its use in instructional programming. Students are required to become familiar with a microcomputer disk operating system.

EdT 313. (CIS 11) Foundations of Instructional Programming in PASCAL (3)
PASCAL for microcomputers. High level, structured, procedure-oriented languages are examined. Special emphasis on use of structured programming for designing instructional software. Students electing EdT 313 are expected to complete the same course requirements as students taking CIS 11. In addition, they are required to become familiar with a microcomputer disk operating system. This is achieved through course assignments requiring the use of a microcomputer. The additional course requirements add an extra hour per week to the student workload.

403. (AdmS/HD/I&C 403) Research (3)
Basic principles of research; techniques of gathering and analyzing data; design of studies in education. Emphasis on critical reviews of research reports representing various methodologies.

EdT 415. Advanced Instructional Programming in BASIC (3)
Advanced features of BASIC such as sequential and direct-access files, sorting, searching, modeling and

simulation. Emphasis on applications in instructional settings. Prerequisite: EdT 311.

EdT 417. (CIS 217) Instructional Programming Techniques in PASCAL (3)
A continuation of structured programming in PASCAL. Special emphasis on the application of sound, color, and graphics in instructional courseware development. Prerequisite: EdT 313.

EdT 419. (CIS 313) Computer Organization (3)
Covers all aspects of programming microprocessors from basic concepts to advanced data structures. Additional topics will include hardware organization, instruction sets, addressing techniques, input/output devices, and application examples. Prerequisite: one high level programming language course (BASIC, FORTRAN, PASCAL, etc.) and consent of program director.

EdT 421. Computer Literacy (3)
An analysis of microcomputer applications designed for use in education and training. Special emphasis is placed on microcomputer applications. Hands-on experience in a microcomputer laboratory.

EdT 425. Learning, Technology and Society (3)
A general survey of the impact of educational technology on modern society. Special attention to the use of large-scale data banks and retrieval systems, problems of privacy, impact of automation on everyday life, and effects of the new learning technologies on curriculum development and education configurations.

EdT 335. Instructional Systems Design
The theory and process of developing and producing instructional units. Essentials for the production of instructional components that can be used directly in the development of microprocessor-controlled instructional units.

EdT 343. (CIS 343) Microcomputer-Aided Instruction (3)
Design and development of microcomputer-assisted instructional units. Students design, program and test microcomputer-aided instructional units as a drill, practice, tutorial, and simulation exercises.

EdT 351. (CIS 351) Cognitive Science (3)
A synthesis of elements of artificial intelligence, psychology and linguistics; concerned with models of the acquisition, representation, storage, retrieval and application of knowledge.

EdT 435. Interactive Learning (3)
Introduction to the utilization of interactive television, video-disc technology and other high technologies for producing instructional software.

EdT 493. Internship (3)
A supervised, field directed, experience in an educational or training environment that utilizes microcomputers in teaching and/or learning.

Electrical and Computer Engineering

Professors. Nikolai Eberhardt, Ph.D., *acting chairman;* Donald M. Bolle, Ph.D., dean of the College of Engineering and Physical Sciences; John J. Karakash, D.Eng., distinguished professor emeritus and dean emeritus of the College of Engineering and Physical Sciences; Walter E. Dahlke, Ph.D.; D. Richard Decker, Ph.D.; Frank J. Feigl, Ph.D.; Bruce D. Fritchman, Ph.D.; Carl S. Holzinger, Ph.D.; Ralph J. Jaccodine, Ph.D.; Arthur I. Larky, Ph.D.; Daniel Leenov, Ph.D.; Amarendra K. Mahalanabis, Ph.D.; Roger N. Nagel, Ph.D.; Alfred K. Susskind, S.M.; Kenneth K. Tzeng, Ph.D.; Marvin H. White, Ph.D.
Associate professors. Frank H. Hielscher, Ph.D.; Karl H. Norian, Ph.D.; John Ondria, Ph.D.; Peggy A. Ota, Ph.D.; Donald L. Talhelm, M.S.
Assistant professors. Douglas R. Frey, Ph.D.; Kalyan Mondal, Ph.D.
Research associate. Mitrajyati Deka, Ph.D.
Adjunct lecturers. James A. Butt, M.S.; Robert A. Donia, M.S.; H. Charles Liebold, M.S.; Michael W. Snovitch, M.S.; Robert A. Spurgeon, M.S.; Sophia W. White, M.S.

The department of electrical and computer engineering offers two undergraduate degree programs, one leading to the bachelor of science in electrical engineering, the other to the bachelor of science in computer engineering.

The two programs are nearly identical until the middle of the junior year, and students can freely move from one to the other. The electrical engineering curriculum prepares graduates for entry into such areas as electronic devices, communication, information and computing systems, control systems, electronic instrumentation, and electrical power systems.

The computer engineering curriculum contains the basic elements of both hardware and software. Because of the pervasiveness of computers throughout modern technology, graduates find career opportunities not only in the computer industry, but also in a broad range of industrial as well as governmental activities.

Both undergraduate programs also can serve as stepping stones into such related areas as bioengineering, computer science, system engineering, or management science.

Courses in the department required for the degree in electrical engineering contain the fundamentals of computing techniques, linear circuits and systems, electronic circuits, signal theory, physical electronics, electromagnetic theory, and energy conversion. Some of these courses include laboratory work; four upper-level laboratory courses are required.

Requirements for the degree in computer engineering include courses in computing techniques, linear circuits and systems, logic design, electronic circuits, signal theory, computer structure, systems programming, discrete mathematics, and numerical analysis. Laboratory sessions are part of some of these courses; three upper-level laboratory courses are required.

A basic assumption underlying the curricula is that the variety of activities in which modern engineers are engaged will continue to remain large, and so provision for mobility of the individual is made by concentrating on broad fundamentals and not on the details of current engineering practice. As a consequence, subjects in physics and mathematics form a substantial block of courses in both curricula, because no matter which direction the individual will follow, such a foundation is essential.

Within electrical engineering, the physical sciences provide the foundation for studies of devices such as transistors, integrated circuits, microwave components, and energy converters. Mathemathics provides the basis for the analytical study of device models and the tools for the analysis, design, and exploitation of systems such as computers, communication networks, and computer software.

About a quarter of the two curricula consists of approved electives, chosen with the consent of an adviser; others require no formal approval. Together, these two groupings provide opportunity for tailoring the program according to individual interests and goals. Some students use the electives for acquiring additional background in preparation for graduate study. Others select senior-year courses in preparation for entry into industry after graduation.

Students are free to select from courses offered by other departments, and are encouraged to do so whenever it serves their individual needs. In this manner, they can prepare themselves for activities that straddle departmental boundaries, or for entry into professional schools such as medicine or management. To maximize the benefits that such flexibility can offer, thorough planning in consultation with an adviser is recommended.

In common with all engineering curricula, both degree programs require a total of at least eight courses in the humanities or the social sciences. Some students utilize this sequence to complete a minor program in one of the other colleges, such as a program in government, economics, or foreign languages. Advisers assist individuals in making appropriate arrangements.

Recommended Sequences of Courses B.S. in Electrical Engineering

(Members of the classes of 1984 and 1985 should consult the 1981-83 catalog for their degree requirements and course descriptions.)

freshman year (see page 46).

sophomore year, first semester (17 credit hours)

Phys 21, 22	Introductory Physics II and Laboratory (5)
Math 23	Analytic Geometry and Calculus III (4)
ECE 81	Principles of Electrical Engineering (4)
ECE 83	Principles of Computer Engineering (4)

sophomore year, second semester (17 credit hours)

ECE 108	Signals and Systems (4)
Math 205	Linear Methods (3)
Eco 1	Economics (4)
	General Study (3)
	approved elective* (3)

junior year, first semester (14-17 credit hours)

ECE 121	Electronic Circuits Laboratory (2)
ECE 123	Electronic Circuits (3)
ECE 125	Circuits and Systems (3)
Math 231	Probability and Statistics (3) **or**
Math 309	Theory of Probability (3)
	General Studies (3)
	elective** (0-3)

junior year, second semester (18 credit hours)

ECE 126	Physical Electronics (3)
ECE 136	Electromechanics Laboratory (2)
ECE 138	Digital Systems Laboratory (2)
ECE 202	Introduction to Electromagnetics (2)
	approved electives* (6)
	elective (3)

senior year, first semester (14-17 credit hours)

ECE 111	Electrical Engineering Proseminar (1)
ECE 151	Senior Laboratory (2)
ECE 203	Introduction to Electromagnetic Waves (2)
	General Studies (3)
	approved electives* (6)
	elective** (0-3)

senior year, second semester (18 credit hours)

	approved electives* (12)
	General Studies (3)
	elective (3)

*Approved electives are subjects predominantly in the area of science and technology. They are not restricted to offerings in the department of electrical and computer engineering. Students must choose at least one elective in mathematics, at least one elective in either materials, thermodynamics, fluid mechanics or physical chemistry, and at least one elective in physics, chemistry or biology. For students interested in solid-state electronics, quantum mechanics is recommended.

**Please refer to graduation requirements, page 46.

Recommended Course Sequences, B.S. in Computer Engineering

sophomore year, first semester (17 credit hours)

Phys 21, 22	Introductory Physics II and Laboratory (5)
Math 23	Analytic Geometry and Calculus III (4)
ECE 81	Principles of Electrical Engineering (4)
ECE 83	Principles of Computer Engineering (4)

sophomore year, second semester (17 credit hours)

ECE 102	Structured Programming (3)
ECE 108	Signals and Systems (4)
Math 205	Linear Methods (3)
Eco 1	Economics (4)
	General Studies (3)

junior year, first semester (14-17 credit hours)

ECE 121	Electronic Circuits Laboratory (2)
ECE 123	Electronic Circuits (3)
ECE 125	Circuits and Systems (3)
Math 231	Probability and Statistics (3) **or**
Math 309	Theory of Probability (3)
	General Studies (3)
	elective** (0-3)

junior year, second semester (17 credit hours)

ECE 116	Software Engineering (3)
ECE 138	Digital Systems Laboratory (2)
ECE 201	Computer Architecture (3)
ECE 317	Discrete Structures (3)
	approved electives* (3)
	elective* (3)

senior year, first semester (15-18 credit hours)

ECE 111	Electrical Engineering Proseminar (1)
ECE 151	Senior Laboratory (2)
Math 230	Numerical Analysis (3)
	General Studies (3)
	approved electives* (6)
	elective** (0-3)

senior year, second semester (18 credit hours)

	approved electives* (12)
	General Studies (3)
	elective (3)

*Approved electives are subjects in the area of science and technology. They are not restricted to offerings in the department of electrical and computer engineering.
**Please refer to description of normal engineering program on page 46.

Course Descriptions

81. Principles of Electrical Engineering (4) fall
Circuit elements and laws. Behavior of simple linear networks. Characteristics of electronic devices and device models. Introduction to functional circuits, such as operational amplifier and logic devices. Principles of electromechanical energy conversion and power systems. Includes a weekly session for review and discussion. Prerequisite: Math 22.

83. Principles of Computer Engineering (4) fall
Microcomputer organization, architecture, and

interfacing. Number systems, Boolean algebra, assembly language programming. Includes a software development laboratory. Prerequisite: Engr 1 or equivalent.

100. Summer Work (0)
Students are expected to spend at least eight weeks getting experience in some industrial organization, normally during the vacation following the junior year. A written report on the experience gained is required.

102. Structured Programming (3) spring
Precedure-oriented languages; the structuring of unstructured programs; software design strategies. Includes a software development laboratory. Prerequisite: ECE 83 or equivalent.

108. Signals and Systems (4) spring
Continuous and discrete signal and system descriptions using signal space and transform representations. Includes Fourier series, continuous and discrete Fourier transforms, Laplace transforms, and z-transforms. Introduction to sampling. Prerequisite: ECE 81.

111. Proseminar (1) fall
A weekly seminar to acquaint students with current topics in electrical and computer engineering. Students prepare and present oral and written reports that are judged on quality and presentation as well as technical content. Prerequisite: senior standing.

116. Software Engineering (3) spring
Software methodologies, data structures, searching, sorting, recursion, trees and linked lists. Prerequisite: ECE 102 or equivalent.

121. Electronic Circuits Laboratory (2) fall
One lecture and one laboratory per week. Experiments illustrating the principles of operation of electronic devices and their circuit applications. Basic electronic instrumentation and measurement techniques. Corequisite: ECE 123, concurrently.

123. Electronic Circuits (3) fall
Methods for analyzing and designing circuits containing electronic devices. Topics include device models, basic amplifier configurations, operating point stabilization, frequency response analysis, and computer-aided analysis of active circuits. Prerequisite: ECE 108.

125. Circuits and Systems (3) fall
Formulation of discrete and continuous circuit equations. Complete solutions of difference and differential equations. Network theorems. State space description of discrete and continuous linear systems. Computer-aided circuit analysis. Prerequisite: ECE 108.

126. Physical Electronics (3) spring
Introduction to wave mechanics, statistics and the theory of solid-state materials. Principles of electron emission and conduction and their applications. Treatment of semiconductor devices including: p-n junctions, junction luminescence, p-n lasers, Impatt and Gunn devices, and Hall devices.

136. Electromechanics Laboratory (2) spring
One lecture and one laboratory per week. An experimental introduction to electromechanical energy conversion. Basic concepts of magnetic fields and forces and their application to electrical apparatus including electromechanical transducers, transformers, AC and DC machines. Prerequisite: ECE 81.

138. Digital Systems Laboratory (2) spring
One laboratory and one lecture per week. Digital measurements, digital instrumentation, logic testing. Characteristics of and design techniques for combinational logic and sequential circuits. Prerequisite: ECE 83 or equivalent.

151. Senior Laboratory I (2) fall
Laboratory projects in any phase of electrical and computer engineering, frequently in the areas of digital systems, communications, instrumentation, electronic circuits, and software. Projects are selected from topics suggested by the students, staff, or industrial concerns. Two three-hour sessions per week. Prerequisite: senior standing.

152. Senior Laboratory II (2) spring
Two choices open, each occupying two three-hour sessions per week.
(1) Project laboratory. Similar to ECE 151.
(2) Microwave laboratory. Introduction to the standard techniques of measurement in the microwave range, such as measurement of impedance with the slotted line and the hybrid tee; two-port parameters; attenuation by substitution and heterodyning. Corequisite: ECE 346, concurrently.

162. Electrical Laboratory (1)
Experiments on circuits, machines, and electronic devices. Elementary network theory. Survey laboratory for students not majoring in electrical or computer engineering. Prerequisite: ECE 81.

For Advanced Undergraduates and Graduate Students

201. Computer Architecture (3) spring
Digital building blocks, conventional computer structure and information flow. Mechanization of arithmetic, storage, and control functions. Input-output systems and controllers. Priority interrupt, direct memory access and other overlapping techniques. Architecture of small ("mini") computers; key features of large ("maxi") machines. Digital design simulation. Prerequisite: ECE 83 or Math 105. Larky

202. Introduction to Electromagnetics (2) spring
Elements of vector analysis. Coulomb's law, Maxwell's equations. Time invariant electric and magnetic fields. Dielectric and magnetic materials. Boundary conditions. Analytical and numerical techniques in static field analysis. Quasistationary fields, inductance. Deka

203. Introduction to Electromagnetic Waves (2) fall
Uniform plane waves. Guided waves. Resonators. Reflections and matching. Poynting's vector. Optical reflection and refraction. Optical fibers. Elements of radiation and diffraction theory. Deka

212. Control Theory (3) fall
Introduction to feedback control. Dynamic analysis of linear feedback systems in the time and frequency domain, with emphasis on stability and steady-state accuracy. Major analytical tools: signal-flow graphs, root-locus method. Nyquist plot, Bode analysis. Cascade compensation techniques. Introduction to sampled data and state-variable concepts. Prerequisite: ECE 125. Mahalanabis or Talhelm

233. Power System Analysis I (3) fall
Determination of transmission line constants: transmission line equations. Synchronous generator representation during steady state and transient conditions. Network reduction by matrix partitioning, network solutions by matrix transformations. Symmetrical components and system faults. Sequence impedances of transmission lines, transformer banks and synchronous generators. Prerequisite: ECE 136. Liebold

234. Power System Analysis II (3) spring
Application of short-circuit impedance matrix to fault studies. Numerical methods for solution of the load flow problem. Economic dispatch and unit commitment. Basic system stability consideration. Prerequisite: ECE 233. Donia

244. Communication Networks (3)
Introductory theory of two-terminal and four-terminal network synthesis. Transmission lines as network elements. Analog and digital filter theory. Prerequisites: ECE 123 and 125. Talhelm

300. Apprentice Teaching in Electrical and Computer Engineering (1-3)
See the introduction to this section.

303. (Met 323) Electrical and Physical Characterization of Defects in Semiconductors (3)
Basic concepts of solid-state physics applied to p-n junction theory. Topics include influence of material growth techniques on defect origination; dislocations induced by diffusions; oxidation-induced stacking faults; the role of imperfections on pipe leakage and soft breakdowns. The relation of materials, defects and processing are highlighted. Jaccodine

305. (Met 321) Failure Analysis of Semiconductor Devices (3)
Fundamental degradation and failure mechanisms that affect the reliability of semiconductor devices. The use of scanning and transmission electron microscopy to examine these mechanisms. Lectures and laboratory. Prerequisite: consent of department chairman. Norian

307. Transistor Circuit Applications (3)
Review of static and dynamic behavior of p-n junctions. Transistor physical electronics, volt-ampere characteristics, and circuit models. Dependence of circuit-model parameters on structure and operating conditions. Tuned amplifiers, feedback amplifiers, and oscillators. Prerequisite: ECE 123. Ondria

308. Transistor Theory (3) fall
Physics of semiconductor materials. Schottky diodes. The p-n junction. Junction field-effect transistors. Bipolar transistors. The MOS system, charge-coupled devices and the insulated-gate field-effect transistor. Prerequisite: ECE 126. Leenov or Norian

311. Compiler Design (3) fall
Principles of artifical language description and design. Sentence parsing techniques, including operator-precedence, bounded-context, and syntax-directed recognizer schemes. The semantic problem as it relates to interpreters and compilers. Dynamic storage allocation, table grammars, code optimization, compiler-writing languages. Prerequisite: consent of department chairman. Spurgeon

315. Principles of Computer Software (3) spring
Machine assembly and macro-language concepts. Study of assemblers, macro-processors, and loaders, and techniques for their construction. Introduction to operating systems as time permits. Prerequisite: consent of the department chairman. Ota

317. (CIS 317) Discrete Structures (3) spring
Series of topics in discrete mathematical structures chosen for their applicability to computer science and engineering. Sets; combinatorics; binary relations and ordering; lattices and Boolean algebra; graphs, trees; generating functions, recurrence relations; groups and rings. Various examples of applications such as job scheduling, sorting, transport networks, and error-correcting codes. Mondal or Tzeng

319. Digital System Design (3)
Design techniques on the register transfer level, with emphasis on VLSI applicability. Definition of AHPL and its use in the design of simple CPUs. Implementation of microprograming, intersystem communications, and interrupt. Interfacing with peripherals. Design verification and simulation. Prerequisite: consent of the department chairman. Susskind

320. Logic Design (3)
Review of basic switching theory. Sequential machine synthesis and associated hardware considerations. Topics such as usage of PLAs and other canonic forms; specification and design of networks not represented by gates; introduction to the theory of logic network simulation and test generation. Susskind

323. Applied Large-Scale Integrated Circuits (3) fall
Operation of various families of logic devices. Study of static and dynamic interconnection problems, including pulse propagation on transmission lines. Static and dynamic RAMs, ROMs, PLAs, SRs, FIFOs and microprocessors. Holzinger

332. Design of Linear Electronic Circuits (3) spring
Introduction to a variety of linear design concepts and topologies, with contemporary audio networks providing many of the concrete examples. Topics include low- and high-level preamps; equalizers and filters; mixers; voltage-controlled amplifiers; input and output stage modifications; power amplifiers; analog switching and digital interface circuitry. Prerequisite: ECE 355. Frey

342. Communication Theory (3) spring
Theory and application of analog and digital modulation. Sampling theory with application to analog-to-digital and digital-to-analog conversion techniques. Time and frequency division multiplexing. Introduction to random processes including filtering and noise problems. Introduction to statistical communication theory with primary emphasis on optimum receiver principles. Prerequisites: ECE 125 and Math 309 or 231. Fritchman

343. Digital Signal Processing (3) fall
Study of one- and two-dimensional orthogonal signal expansions and their discrete representations, including the Discrete Fourier Transform and Walsh-Hadamard Transform. Development of fast algorithms to compute these, with applications to feature extraction and two-dimensional image processing. Introduction to the z-transform representation of numerical sequences with applications to input/output analysis of discrete systems and the design of digital filters. Analysis of the internal behavior of discrete systems using state variables for the study of stability, observability and controllability. Prerequisite: ECE 125. Fritchman

345. Speech Synthesis and Recognition (3) fall
Application of digital technology to generation and recognition of speech by machines. The analytical tools required for digitizing and encoding speech signals; the methods currently used for synthesizing and recognizing speech; various hardware products available to perform these tasks. Holzinger

346. Microwave Circuits and Techniques (3) spring
Impedance transformation along waveguides. Matching techniques. Applications of Smith Chart. Resonators as circuit elements. Scattering and transfer matrices. S-parameter design of transistor amplifiers. Stability. Noise. Reflection-type amplifiers. Prerequisite: ECE 203 or eqivalent. Eberhardt

348. Digital Control Systems (3) spring
Review of z-transform theory; sample-hold, A/D and D/A devices; modeling of discrete time systems; analysis of discrete time systems using z-transforms and state variables; frequency domain design of digital compensators; design of digital controllers in time domain. Prerequisite: ECE 212 or equivalent. Mahalanabis

350. Special Topics (3)
Selected topics in the field of electrical and computer engineering not included in other courses. May be repeated for credit.

351. Microelectronics (3)
Technology of semiconductor devices and of integrated circuits, including crystal growth and doping, phase diagrams, diffusion, epitaxy, thermal oxidation and oxide masking, photolithography, thin film formation. Effects of these processes on the design of transistors and integrated circuits. Prerequisite: ECE 126 and Phys 31 or consent of the department chairman. Hielscher

355. Applied Integrated Circuits (3)
Emphasis on understanding of terminal characteristics of integrated circuits with excursion into internal structure only as necessary to assure proper utilization in system design. Classes of devices studied include operational amplifiers, digital-to-analog and analog-to-digital converters, linear multipliers, modulators, and phase-locked loops. Prerequisites: ECE 123 and 125. Holzinger

361. Introduction to VLSI Circuits (3)
Analysis and design of analog and digital minicells and macrocells for very large scale integrated (VLSI) circuits on a silicon chip. NMOS and CMOS technology emphasis, CAD layout, SPICE circuit simulation, timing, symbolic representation, and chip fabrication methods. Laboratory involves interactive graphics system operation, file management, macros, utilities, design rule checks, and CAD layout of integrated circuits. White

For Graduate Students

Graduate study leading to the master of science, master of engineering and doctor of philosophy degrees is available in the department of electrical and computer engineering. None of the advanced degree programs has a fixed curriculum, and courses are selected by the individual in consultation with advisers.

Study leading to the M.S. degree emphasizes the scientific aspects of electrical and computer engineering and requires the submission of a six-credit-hour thesis. Programs leading to the M.E. degree include design-oriented courses and cover a range of areas. Completion of an engineering project is required.

Subject to approval by departmental advisers, graduate degree programs frequently include as part of the "major" courses in physics and mathematics that provide a foundation for advanced work.

Students in the Ph.D. program are required to take the qualifying examination within one year after obtaining the M.S. This examination tests competency in general areas of electrical engineering. A second examination in the candidate's area of specialization is taken at some time up to the last year of the program. Competence in a foreign language is not a required part of the Ph.D. program in electrical and computer engineering.

Members of the department are particularly interested in advanced work in the following areas: semiconductor devices and integrated circuits (microelectronics); microwave components and circuits; electrooptics; electronic materials; instrumentation and sensors; robotics; control systems; power systems; computer languages; computer hardware and software systems; communications and decision theory; fault-tolerant computing; pattern recognition; algebraic coding theory; computer networks; switching theory and logic design; digital signal processing.

The facilities of the department of electrical and computer engineering are located primarily in Packard Laboratory. The department also shares the facilities of the Sherman Fairchild Laboratory for Solid-State Studies and the Lehigh CDC CYBER 170 model 720 computer and DEC 20 system.

Facilities for experimental work in electronics and communication cover the spectrum through microwave frequencies and into optic wave lengths. Special research facilities, including a shielded room, are available for the study of devices, noise in semiconductor networks, and digital functions. The department has an HP-1000 computing system with a variety of peripherals, numerous microcomputer systems, and a variety of ancillary building blocks.

Microelectronics facilities for the preparation and investigation of semiconductor technology, devices and circuits are located in the Sherman Fairchild Laboratory. Computer-aided design is performed with an Applicon 860 interactive graphics system and device/circuit modeling with numerical simulation programs. Device and circuit fabrication emphasizes CMOS technology for analog and digital circuits together with custom sensor microelectronics. Technology includes diffusion, oxidation, ion implantation, photolithography, metallization, chemical vapor deposition, and packaging. Computer-aided data acquisition is performed with an HP 9836 computer and IEEE 488 bus-controlled peripherals. Emphasis is on solid-state device modeling and novel device/circuit characterization. In addition, facilities of other departments, including X-ray facilities, electron microscope, scanning electron microscope, electron microprobe, and Auger spectrometer, are available.

Information about the department's graduate programs may be obtained by contacting Professor D. Leenov, graduate adviser.

Courses for Graduate Students

403. Design of Operating Systems (3)
Principles of operating systems with emphasis on hardware and software requirements and design methodologies for multi-programming systems. Global topics include the related areas of process management, resource management, and file systems. Prerequisite: ECE 315 or equivalent. Ota

404. Computer Networks (3)
Study of architecture and protocols of computer networks. The ISO model; network topology; data-communication principles, including circuit switching, packet switching and error control techniques; sliding window protocols, protocol analysis and verification; routing and flow control; local area networks; network interconnection; topics in security and privacy. Tzeng

407. Linear and Nonlinear Optics (3)
Gaussian beams. Optical waveguides and resonators. Introduction to laser physics. Crystal optics with attention to nonlinear effects. Harmonic and subharmonic generation. Parametric amplifications. Brillouin and Raman scattering. Classical diffraction theory. Holography with applications. Eberhardt

411. Information Theory (3)
Introduction to information theory. Topics covered include: development of information measures for discrete and continuous spaces, study of discrete-stochastic information courses, derivation of noiseless coding theorems, investigation of discrete and continuous memoryless channels, development of noisy channel coding theorems. Fritchman

412. Advanced Digital Signal Processing (3)
Optimum design of linear-phase, FIR, digital filters. Design of general and special-purpose signal processors including finite word-length effects. Discrete-time processing of random processes including spectrum estimation. State-variable description of discrete-time systems and their application to Kalman filtering. Prerequisite: ECE 343 or equivalent. Fritchman

425. Power System Analysis (3)
Basic concepts including per-unit representations; symmetrical three-phase transmission systems; power transformers; three-phase synchronous generators; transmission lines; modeling and power flow analysis of systems in steady state. Mahalanabis, staff

426. Power System Dynamics and Stability (3)
State space models of synchronous generator; model of a simple power system with a single machine connected to infinite bus; model of multi-machine power system; dynamic and transient stability of single and multi-machine systems. Prerequisite: ECE 425 or eqivalent. Mahalanabis, staff

427. Power System Control (3)
Control problems for power systems in the steady state; automatic voltage regulators; load frequency control of single area system, load frequency control of multi area system; automatic generation control in interconnected power system; power system instrumentation; load control centers. Prerequisite: ECE 425 or equivalent. Mahalanabis, staff

428. Power System Protection (3)
Surge phenomena in power systems; symmetrical faults; unbalanced system analysis; different types of relays; solid-state protection devices; transmission line protection; protection of generators and motors; transformer protection. Prerequisite: ECE 425 or equivalent. Mahalanabis, staff

429. Power System Optimization (3)
The problem of optimal economic operation of a power system; modeling for optimum operations; review of linear and nonlinear programming; elements of dynamic programming and maximum principle; optimization of thermal, hydro and hydro-thermal systems. Prerequisite: ECE 425 or equivalent. Mahalanabis

431. Topics in Switching Theory (3)
Emphasis on structural concepts motivated by recent advances in integrated circuit technology. Major topics include: logical completeness, error detection and location; decomposition techniques; synthesis with assumed network forms; fault masking in switching circuits. Prerequisite: consent of department chairman. Susskind

432. Finite State Machines (3)
Description of sequential behavior; Gendanken experiments; error control; information losslessness, iterative systems. Synthesis of sequential machines in canonic forms and as asynchronous circuits. Prerequisite: consent of department chairman. Susskind

435. Error-Correcting Codes (3)
Error-correcting codes for digital computer and communication systems. Review of modern algebra concentrating in groups and finite fields. Structure and properties of linear and cyclic codes for random or burst error correction covering Hamming, Golay, Reed-Muller, BCH and Reed-Solomon codes; construction of Goppa codes and their recent generalizations. Decoding algorithms and implementation of decoders. Prerequisite: ECE 317 or equivalent. Tzeng

444. Microwave Devices (3)
Optical masers. Cavity and traveling wave masers. Devices using ferrimagnetic resonance: isolators, circulators, electronically controlled phase shifters. Parametric amplifiers. Amplifiers and oscillators using active semiconductor devices. Eberhardt

445. Applied Electromagnetic Theory (3)
Advanced electromagnetics. Emphasis on planar structures for integrated circuit technology at microwave through optical wavelengths. Examination of the properties and applications of structures such as microstrip, slotline, dielectric waveguides, isolators, phase shifters, circulators and couplers. Bolle

446. Millimeter and Submillimeter Wave Devices (3)
Study of millimeter and submillimeter wave system components. Theoretical considerations, modelling, measurement techniques and design considerations is explored at a level consonant with the background of the students enrolled. The work is based on journal literature. Prerequisite: ECE 445 or consent of the department chairman. Bolle

447. Nonlinear Phenomena (3)
Investigation of nonlinear effects in active and passive lumped and distributed circuits with emphasis on methods of analysis as well as physical understanding of jump phenomena, van der Pol's theory, stability criteria, phase locking. Transmission line and optical waves in nonlinear media; shock waves, harmonic generation and optical parametric amplification. Eberhardt

448. (ME 448) Optimal Control & Design Theory (3)
Parameter optimization in design and optimal open loop and feedback control via the extrema of unconstrained and constrained functions and functionals (calculus of variations). Matrix and state space formulation. Language multipliers, Pontryagin maximum principle, Hamilton-Jacobi theory, matrix Ricatti equations, sensitivity analysis. Survey of observability and controllability, dynamic programming, and Kalman filter. Intended for engineers with a variety of backgrounds. Prerequisite: ECE 212 or ME 340 or 343 or ChE 286. Brown

450. Special Topics
Selected topics in electrical and computer engineering not covered in other courses. May be repeated for credit.

451. Physics of Semiconductor Devices (3)
Transport theory, lattice vibrations, electronic conduction, thermoelectric effects. Theory of recombination. Energy band structure. Applications to p-n junctions. Prerequisites: Phys 31 and ECE 126 or equivalent. Decker or Leenov

452. Theory of Microwave Semiconductor Devices (3)
Hot electrons, secondary ionization, avalanche breakdown, electron transfer by intervalley scattering. Applications to microwave components such as avalanche and Gunn diodes, Schottky diodes, tunnel diode and PIN diodes. Prerequisite: ECE 451. Decker

454. Theory of Optoelectronic Devices (3)
Optical electronics. Theory of radiation, radiative absorption and emission in semiconductors. Applications to optical electronic devices: electroluminescence, light-emitting diodes, lasers. Detection and modulation of optical radiation, solar cells and photodetectors. Prerequisite: ECE 451. Decker

455. Theory of Metal Semiconductor Diodes and Field Effect Transistors (3)
Properties of metal semiconductor contacts, ohmic contacts, Schottky barriers, minority carrier injection, etc. Properties of metal semiconductor field effect transistors (MESFETS), equivalent circuits, applications to microwave amplifiers, oscillators, switching circuits, etc. Prerequisite: ECE 451. Decker

460. Engineering Project (3-6)
Project work in an area of student and faculty interest. Selection and direction of the project may involve interaction with industry. Prerequisite: consent of department chairman.

461. Theory of Electrical Noise (3)
Definitions: noise temperature, spectral density. Noise sources: quantum, thermal, shot, generation-recombination, flicker noise. Representation and optimization of noisy networks. Prerequisites: Phys 31 and ECE 126. Decker

463. Design of Microwave Solid State Circuits (3)
Equivalent circuit modeling and characterization of microwave semiconductor devices, principles of impedance matching, noise properties and circuit interaction, introduction to the design of high-power and non-linear circuits. Decker

476. Analysis and Design of Analog Integrated Circuits (3)
Circuit models of bipolar and junction field-effect transistors. Analog integrated circuit technology. Passive components and distributed elements. One- and two-transistor amplifier stages, current sources and active loads, output stages. Design of operational amplifiers. Analysis of frequency circuits. Prerequisite: ECE 308. Hielscher

478. Analysis and Design of Digital Integrated Circuits (3)
Large signal models and transient behavior of MOS and bipolar transistors. Basic inverter and logic gate circuits. Noise margins, operating speed, and power consumption of various logic families, including MOS, CMOS, saturated logic (TTL), ECL, and I^2L. Regenerative logic circuits and digital memories. Circuit design and computer-aided circuit analysis for LSI and VLSI circuits. Prerequisite: ECE 308. Hielscher

483. Advanced Semiconductor Devices for VLSI Circuits (3)
Theory of small geometry devices for VLSI Circuits. Emphasis of MOS bipolar device static and dynamic electrical characteristics. Carrier injection, transport, storage, and detection in bulk and interfacial regions. Limitations of physical scaling theory for VLSI submicron device structures. MOS physics and technology, test pattern device structures, charge-coupled devices, MNOS nonvolatile memory devices, and measurement techniques for device and process characterization. The influence of defects on device electrical properties. Prerequisite: ECE 451. M. White

484. Dielectric Materials in VLSI and Optoelectronics (3)
Electronic and optical properties of silicon dioxide and other dielectric materials, including optical excitations, charge carrier transport and trapping, and interface phenomena. Applications to dielectric crystal, film, and fiber structures in integrated circuit, optical communication, and VLSI technologies. Emphasis on specific topics of current interest. Prerequisite: ECE 451 or equivalent. Feigl

486. Integrated Solid-State Sensors (3)
The physical operation of sensor-based, custom-integrated circuits. Emphasis on the integration of sensors, analog, and digital circuits on a silicon chip with CMOS technology. Sensors include photocells, electrochemical transducers, strain gauges, temperature detectors, vibration and velocity sensors, etc. Analysis of sensor-circuit performance limits including signal-to-noise, frequency response, temperature sensitivity, etc. Examples of sensor-based, custom I.C.s are discussed and analyzed with CAD modeling and layout. Prerequisite: ECE 451. M. White

493. Solid State Electronics Seminar (3)
Discussion of current topics in solid-state electronics. Topics selected depend upon the interests of the staff and students and are allied to the research programs of the Sherman Fairchild Laboratory for Solid-State Studies. Student participation via presentation of current research papers and experimental work. Prerequisite: consent of department chairman. May be repeated for credit. Dahlke

Electrical Engineering and Engineering Physics

This curriculum is particulary well suited for students seeking thorough preparation in the field of physical electronics. The program adds to the basic electrical engineering curriculum a sequence of upper-level undergraduate physics courses.

The electrical engineering degree is conferred on the completion of the fourth year, and the engineering physics degree at the end of the fifth year. Both are bachelor of science degrees. Interested students should contact W. Beall Fowler, chairperson of the department of physics, for information.

freshman year in engineering (see page 46)

sophomore year, first semester (17 credit hours)

ECE 81	Principles of Electrical Engineering (4)
ECE 83	Principles of Computer Engineering (4)
Math 23	Analytical Geometry and Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)

sophomore year, second semester (17 credit hours)

ECE 108	Signals and Systems (4)
Math 205	Linear Methods (3)
Phys 31	Introduction to Quantum Mechanics (3)
Eco 1	Economics (4)
	General Studies requirement (3)

junior year, first semester (17 credit hours)

ECE 123	Electronic Circuits (3)
ECE 121	Electronic Circuits Laboratory (2)
ECE 125	Circuits and Systems (3)
Math 231	Probability and Statistics (3) *or*
Math 309	Theory of Probability (3)
Phys 212	Electricity and Magnetism I (3)
	General Studies requirement (3)

junior year, second semester (13-16 credit hours)

ECE 126	Physical Electronics (3)
ECE 136	Electromechanics Laboratory (2)
ECE 138	Digital Systems Laboratory (2)
Phys 213	Electricity and Magnetism II (3)
	mathematics elective (3)
	electives (0-3)*

summer

ECE 100	Industrial Employment

senior year, first semester (15-18 credit hours)

ECE 111	Proseminar (1)
ECE 151	Senior Laboratory I (2)
Phys 215	Particles and Fields I (3)
ECE	departmental elective (3)
	General Studies requirement (3)
	electives (3-6)*

senior year, second semester (18 credit hours)

Phys 362	Atomic and Molecular Structure (3)
ECE	departmental electives (9)
	General Studies requirement (3)
	elective (3)

fifth year, first semester (17 credit hours)

Phys 216	Particles and Fields II (3)
Phys 273	Research (2) *or*
Phys 260	Laboratory Techniques (2)
Phys 340	Thermal Physics (3)
Math 322	Methods of Applied Analysis I (3)
	approved elective (3)**
	elective (3)

fifth year, second semester (15 credit hours)

Phys 261	Optics, Spectroscopy, and Quantum Physics Laboratory (2)
Phys 171	Proseminar (1)
	approved electives (6)**
	electives (6)

*Please refer to description of normal program, page 46.
**Approved electives include two courses selected from Phys 346, 352, 363, 364, 365, 366, 367, 368, and 369.

Engineering

Engr 1 is required of all engineering majors and is taken in the recommended freshman year as described on page 46.

1. Introduction to Engineering (3) fall-spring
Introduction to the solution of engineering problems through the use of the computer. Elementary computer programming in FORTRAN is taught and illustrated by means of several topics in computational mathematics such as roots of equations, matrices, least squares analysis, numerical integration, and others. No previous knowledge of computer programming is assumed. Also, during the laboratory period, a series of lectures and demonstrations are given, outlining the career opportunities available in the various disciplines represented in the College of Engineering and Physical Sciences. Prerequisite: Math 21 or 31, previously or concurrently.

250. Computer Modeling of Scientific and Engineering Systems (3)
Introduction to the mathematical modeling of scientific engineering systems, with emphasis on higher-order nonlinear models for which analytical methods are precluded. Solution of the model equations by computer-based numerical algorithms. Introduction to numerical methods for linear and nonlinear algebraic systems, ordinary and partial differential equations. Error analysis and control, stability and convergence in numerical calculations. Prerequisites: Engr 1; Math 205, previously or concurrently. Schiesser

Engineering-M.B.A. Program

The bachelor in engineering-master of business administration two-degree program is designed to meet the needs of especially competent students in any engineering curriculum who want to add to their engineering studies training in business management at an advanced level.

The time involved will vary depending on the student's background. One or more summer sessions in addition to two or more regular semesters of study may be necessary after completion of the bachelor's degree in engineering to attain the M.B.A. or M.S. in management science. Candidates take the Graduate Management Admission Test and meet the standards for admission into The Graduate School.

For background courses required for the master of business administration program, engineering students should read Section IV, Graduate Study in Business and Economics, and consult with Joseph P. Klein, assistant dean of the College of Business and Economics.

English

Professors. Frank S. Hook, Ph.D., *chairperson;* Peter G. Beidler, Ph.D., Lucy G. Moses Distinguished Professor; Jack A. DeBellis, Ph.D.; James R. Frakes, Ph.D., Edmund W. Fairchild Professor of American Studies; David M. Greene, Ph.D.; Albert E. Hartung, Ph.D., Distinguished Professor; John W. Hunt, Ph.D., dean of the College of Arts and Science; E. Anthony James, Ph.D.; John F. Vickrey, Ph.D.
Associate professors. Rosemarie Arbur, Ph.D.; Addison C. Bross, Ph.D.; Jan S. Fergus, Ph.D.; Elizabeth Fifer, Ph.D.; Edward J. Gallagher, Ph.D.; Robert R. Harson, Ph.D.; Rosemary Mundhenk, Ph.D.; Barbara H. Traister, Ph.D.
Assistant professor. Michael Pressler, Ph.D.

The department of English offers majors in literature, journalism, and theater. Speech and Theater and Journalism are divisions of the department. For information about their programs and course offerings, consult the separate listings in this section of the catalog.

Courses in English language and literature may be considered a general preparation for any decent kind of living. These courses require close attention to words and at the same time encourage that loving respect for the true naming of things, which is the source of all clear and honest thought.

In literature itself, which is words that we wish to hear again and yet again, we may find a happy companionship with minds that can help our own grow straight with grace and understanding. A head that is full of poetry is a good one to live with.

Undergraduate Major in English

The major in English is designed to give interested students: experience in reading, analyzing, and formulating thoughts about what Matthew Arnold called "the best that has been thought and said"; an understanding of how literary artists find the appropriate words to express their thoughts and feelings; and a basic knowledge of the historical development of British and American literature.

Students who major in English often go on to careers in teaching, writing, law, or business, but the analytical and communication skills acquired in the study of literature and writing will be of use in almost any profession or human activity. Depending on their interests, abilities, and career plans, students who major in English are encouraged to consider double majors or minors in other fields. The major in English is flexible enough to allow cross-disciplinary study with ease.

The student majoring in English has considerable freedom to choose from an extensive list of courses. To insure breadth of coverage, each major is required to take Engl 25 and 26, British Literature, and Engl 23, American Literature, first semester. These three courses are designed to acquaint the student with the important British and American writers, and with certain movements and trends in literature before the twentieth century.

To insure depth of understanding of at least two basic early writers, each English major is required to take either Engl 329 or 330, Shakespeare and Elizabethan Drama, and either Engl 327, Chaucer, or Engl 331, Milton. In addition to these five courses, each English major elects five additional courses in either English or American literature, at least two of which are in

literature before 1900 and at least three of which are numbered above 300.

It should be emphasized that thirty is the *minimum* number of hours for the major; many English majors will elect to take more. Each English major has a departmental adviser to assist in selecting courses for the major program.

The department of English strongly recommends that any student contemplating the possibility of advanced study of English or American literature or of becoming a teacher of English should work toward departmental honors.

In order to receive departmental honors the English major attains a 3.50 grade average in courses presented for the major and must complete 39 hours of course work in English. Fifteen of these hours (five courses) are those required for the regular English major: Engl 23, 25 and 26, Engl 329 or 330, and Engl 327 or 331. Twelve hours (four courses) should be chosen from among the department's advanced period courses (Engl 360, 362, 364, 367, 369, 371, 376, 377, 378, 379, 380, 385 and 386), at least two of which must be in literature before 1900; three hours (Engl 181) are in the form of a thesis of substantial length (normally 25 to 50 pages).

The department of English also recommends that students working for departmental honors elect Engl 148, Introduction to the English Language; that they develop a competency in at least one foreign language; and that they consider petitioning in their senior year to take one of the department's graduate seminars at the 400 level. Students who complete the courses required for departmental honors but who do not achieve the necessary grade-point average will receive the bachelor of arts degree with a major in English.

Minors in English

The department of English offers two minors, each requiring fifteen hours of course work beyond freshman English. For a minor in English, a student takes Engl 25 and 26, British Literature, and an additional nine hours in British literature, at least six of them in British literature at the 300 level.

To minor in American Literature, a student takes Engl 23 and 24, American Literature, and an additional nine hours in American literature, at least six of them in American literature at the 300 level. The student's major adviser monitors the minor program but the student should consult the minor adviser in the department of English when setting up a minor program.

Graduate Work in English

The objective of the graduate program in English is not simply to impart knowledge, however wide or deep, but also to instruct the student in the methods of pursuing advanced study of literature and to provide training in the techniques of criticism and research, and in pedagogical approaches to literature.

A primary aim of the program is to furnish course work and individual instruction suitable for teachers of English at the secondary and college levels. Advanced degrees may be obtained in all areas of English and American literature. In 1982-83 about fifty candidates were enrolled in the graduate programs in English.

Students who wish to enter the graduate program in English should have an undergraduate major in English with at least fifteen semester hours of advanced courses in English literature. Students who did not major in English may be admitted, but will be expected to make up deficiencies in their undergraduate training in English in addition to satisfying other minimum requirements for the graduate degree sought.

Candidates for the master's degrees in English who expect to continue for the doctor of philosophy degree are required to complete successfully twenty-seven semester hours of course work and to write a thesis representing the equivalent of three hours of course work. Master's degree candidates who do not wish to continue for the Ph.D. may, as an alternative, complete successfully twenty-seven hours of course work and pass an examination, preparation for which represents the equivalent of three hours of course work (see Engl 495). Details concerning the examination are available from the director of graduate studies.

Candidates for the master's degree whose needs and interests make it desirable may substitute up to six hours of collateral work in other departments. Master's candidates must take at least half of their required courses in 400-level seminars, but may select the balance of their curriculum from a variety of 300-level course offerings. At least six hours of course work for the master's degree should be in literature before 1660.

Candidates for the doctor's degree are accepted only after a consultation among the graduate professors concerning the candidate's qualifications. Each candidate is required to take at least one course from the following sequence: Engl 421, History of the English Language; Engl 423, Old English; and Engl 424, Beowulf.

The foreign language requirement for the doctor of philosophy (usually in Latin, French or German) may be satisfied in one of two ways: 1. the demonstration, through examination, of a reading knowledge of two foreign languages; or 2. the successful completion, concurrent with the graduate program, of a foreign language course, to be approved by the departmental director of graduate studies, at the 200, 300, or 400 level (or at a lower level in classical languages).

For the doctoral examination each candidate selects the following to be examined upon:

1. One of the following traditional periods: Old English and Medieval; Renaissance and Jacobean, 1500-1660; Restoration and Eighteenth century, 1660-1798; Romantic and Victorian, 1798-1900; American Literature, Colonial-1899; Modern British and American Literature, 1900-present.
2. A major figure, to be selected in consultation with the director of graduate studies and subject to the approval of the departmental graduate committee.
3. A genre, theme, matter, or customary grouping, to be selected in consultation with the director of graduate studies and subject to the approval of the departmental graduate committee.

In each of the three areas of the examination the candidate is expected to demonstrate the knowledge and expertise that would be necessary to teach a course in the subject. The three areas may not overlap except for, in rare instances, the third.

Freshman Courses

With the two exceptions noted below, all undergraduate students take six hours of freshman English courses: English 1 and one of the five options for the second semester, Engl 2, 4, 6, 8, 10. The exceptions are:

1. Advanced placement and six semester hours of Lehigh credit for freshman English are given to students who earn a score of 5 on the College Board Advanced Placement Test in English. These students need not take the regular freshman English courses (English 1, 2, 4, 6, 8, 10), but they are encouraged to elect Engl 11 and 12, seminars designed to give advanced freshman practice in reading and writing at the college level. Students who receive a grade of 4 on the Advanced Placement Test in English or who have a score of 700 or higher on the SAT Verbal Aptitude Test will receive three hours of credit in freshman English; these students will complete the six-hour requirement by taking Engl 2, 4, 6, 8, 10, 11, 12 or 71. Students in this category should seek advice from the Department of English about which courses to roster. Students who have an SAT Verbal Aptitude Test score between 650 and 699 and who have received a grade of 3 on the College Board Advanced Placement Test in English may apply to the department of English for an anticipatory or special examination which, if completed

successfully, will result in three hours of credit and exemption from Engl 1.

2. Undergraduate foreign students. Foreign students are students in the United States on non-immigrant visas.

Foreign students for whom English is not the native language are expected to have a level of proficiency in both oral and written English that will enable them to function adequately in their chosen curricula. All matriculating undergraduate foreign students whose native language is not English are required to take an English proficiency examination administered by the department. Those whose level of competence is judged to be adequate receive six hours of credit in English. Those whose level of competence is inadequate will be required to enroll in Engl 3, English as a Second Language, until they achieve the necessary level; at that time they will receive six hours of credit in English. The requirement is a competency requirement. No credit hours are given for the course; no grade is given in the course.

Foreign undergraduate students for whom English is the native language are treated as American students. Undergraduate students on immigrant visas and citizens of the United States either by birth or by naturalization, for whom English is not the first language may petition to replace the regular freshman English requirement with the requirement for foreign students. Students who wish to be considered for this option should consult the department.

Courses in English

1. Composition and Literature (3)
The art of expository writing. Appropriate collateral reading.

2. Composition and Literature: Fiction, Drama, Poetry (3)
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of drama, short fiction, and verse. Prerequisite: Engl 1.

3. English As a Second Language (0)
Oral and written English for non-native speakers. No grades are given. When students achieve the required level, they receive six hours of credit in English.

4. Composition and Literature: The Novel (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with study of selected novels. Prerequisite: Engl 1.

6. Composition and Literature: Drama (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of literary and theatrical aspects of several classic and contemporary plays. Prerequisite: Engl 1.

8. Composition and Film Study (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of film.

10. Composition and Literature: Fiction (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of short stories, novellas, and novels.

11. Literature Seminar for Freshmen (3) fall
Discussion of and writing about selected masterworks of literature. Open as an elective to any freshman exempt from the regular freshman English requirement.

12. Literature Seminar for Freshmen (3) spring
Discussion of and writing about selected masterworks of literature. Open as an elective to any freshman exempt from the regular freshman English requirement. Upon recommendation of the English 1 instructor, a freshman may complete the English composition requirement by taking this course instead of Engl 2, 4, 6, 8, or 10.

Basic Undergraduate Courses

The following courses are open to any student who has completed, or who is exempt from, the required six hours of freshman English. Students may roster one of the following as a second English course to be taken concurrently with Engl 2, 4, 6, 8, or 10, if they have earned a grade of B or above in Engl 1 and if they obtain the consent of the instructor in the second course.

23. American Literature (3) fall
Significant American writing from the settlement through the middle of the 19th century. Prerequisite: six hours of freshman English.

24. American Literature (3) spring
American literature from the middle of the 19th century to the present. Prerequisite: six hours of freshman English.

25. British Literature (3) fall
British literature from Beowulf through the pre-Romantics. Prerequisite: six hours of freshman English.

26. British Literature (3) spring
British literature from Wordsworth to Auden. Prerequisite: six hours of freshman English.

53. The Short Story (3)
English, American and continental short story. Class dicussions, collateral reading, and reports. Prerequisite: six hours of freshman English.

59. World Literature (3)
Great works from the literature of epic poetry, drama, romance, and essay that illustrate the humanistic traditions of Western civilization. Prerequisite: six hours of freshman English.

63. Narrative Film (3)
History and aesthetics of narrative film. Prerequisite: six hours of freshman English. Pressler

71. Expository Writing Workshop (1-3)
Practice in and criticism of expository writing beyond the freshman level. May be repeated for credit as topic varies. Prerequisite: six hours of freshman English.

72. Words (1)
How to improve your spelling, vocabulary, and diction through study of word formation: etymology, prefixes, suffixes.

73. Creative Writing Workshop (1-3)
Practice in and classroom criticism of creative writing done by students taking the course. Title may vary: Short Story; Drama; Poetry; etc. May be repeated for credit. Prerequisite: six hours of freshman English.

74. Editing the Manuscript (1)
How to improve your papers by editing: spelling, punctuation, proper usage, and correct grammar.

85. Performing Literature (1-3)
Study of and practice in literature to be performed before an audience. Title will vary: Readers Theater. May be repeated for credit as title varies.

89. Science Fiction (3)
The genre with emphasis on its role as creator and reflector of attitudes toward scientific and technological advances. Prerequisite: six hours of freshman English. Arbur

91. Special Topics in English (1-3)
A characteristic topic or genre or approach in literature not covered in other courses. Prerequisite: six hours of freshman English.

Upperclass Undergraduate Courses

The following courses are more advanced than the courses that appear in the preceeding list, but they are by no means designed exclusively for specialized students. Each course is a self-contained unit and has no prerequisites beyond the two semesters of freshman English.

The purpose of most of the courses listed below is to acquaint students from all segments of the university with the best that has been written through the ages by the most effective literary artists. *These courses may be used to fulfill preliminary or upperclass distribution requirements for students in the College of Arts and Science.*

129. Shakespeare and Elizabethan Drama (3) fall
Study of the earlier plays of Shakespeare, mostly comedies and histories. Selected plays from contemporary dramatists such as Marlowe, Greene, and Jonson. Meets with Engl 329, but has a reduced reading and written assignment load. Prerequisite: six hours of freshman English. Hook, Traister

130. Shakespeare and Elizabethan Drama (3) spring
Study of the later plays of Shakespeare, the tragedies and romances. Selected plays from contemporary dramatists such as Webster, Tourneur, Middleton. Meets with Engl 330, but has a reduced reading and written assignment load. Prerequisite: six hours of freshman English. Hook, Traister

148. Introduction to the English Language (3) spring, 1984
Basic linguistic concepts together with a historical survey of the English language. Vickrey

150. (Phil 150) Media and Values (3)
How mutual interaction forms and reforms media and values. Humanistic criticism and philosophical analysis of the principal media (the human body, language, film, television, architecture, art) through which human values arise and take their place in the world.

151. The Drama (3)
Selected plays; theories of drama; drama and the stage. Prerequisite: six hours of freshman English.

155. The Novel (3)
Selected novels as works of literature. Prerequisite: six hours of freshman English.

157. Poetry (3)
Traditional and modern poetry read for pleasure and understanding. Prerequisite: six hours of freshman English.

175. Individual Authors (1-3)
Intensive study of the works of one or more literary artists. Title will vary: Hemingway; Tolkien. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

177. Individual Works (1-3)
Intensive study of one or more literary works. Title will vary: Moby Dick; Stories of John Cheever. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

179. Character Types in Literature (1-3)
Study of a character type in several works of literature by several authors. Title will vary: The Scientist in Drama and Fiction; The Magician in Literature. May be repeated for credit as the title varies. Prerequisite: six hours of freshman English.

181. Undergraduate Thesis (3)
Open to advanced undergraduates who wish to submit theses in English. Prerequisite: consent of the department chairperson.

183. Readings in English and American Literature (3)
Open to advanced students who wish to pursue special or independent courses of reading in literary study. Prerequisite: consent of the department chairperson.

187. Themes in Literature (1-3)
Study of a recurring theme as it appears in several works of literature. Title will vary: Utopian Literature; Censorship and Literature. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

189. Popular Literature (1-3)
A form of literature that is or has been of interest primarily to a "popular" audience. Title will vary: Folklore; Detective Fiction. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

191. Special Topics (1-3)
A topic, genre, or approach in literature or writing not covered in other courses. Prerequisite: six hours of freshman English.

263. Studies in Film History and Criticism (3)
Intensive study of certain films dealing with a genre, director, theory, period, or theme. Prerequisite: consent of department chairperson. Pressler

291. Special Topics (1-3)
A topic, genre, or approach in literature or writing not covered in other courses. Prerequisite: six hours of freshman English.

300. Apprentice Teaching (3)
Supervised participation in various aspects of the teaching of a course. Prerequisite: consent of the department chairperson.

301. Topics in Literature (1-3)
A theme, topic or genre in literature. Title will vary: Autobiography as Literature; British Drama. May be repeated for credit as title varies.

303. Advanced Expository Writing (3)
Practice in writing: structure and style. Students select their own subject. Prerequisite: Engl 71 or consent of the department chairperson.

311. Literature of Women (3) fall, 1984
Literature by and about women, including both acclaimed and little-known works. Arbur

312. Jewish Literature (3) spring, 1984
Development of Jewish literature (including Yiddish literature in translation) from Russian and Eastern European beginnings to immigration and assimilation in America. Fifer

316. The Indian in American Literature (3)
The American Indian as portrayed in folklore, poetry, and fiction in America. Works written by both Indian and non-Indian writers. Beidler

319. The Black in American Literature (3)
Black characters and the literary treatment of the black experience in American fiction and drama from 1850 to the present. Comparative examination of both black and non-black authors, such as W.W. Brown, Stowe, Melville, Twain, Chestnutt, Hughes, Toomer, Faulkner, Wright, Baldwin, Ellison, Styron, and Baraka. Frakes

327. Chaucer (3) fall, 1984
The chief works of Geoffrey Chaucer, with attention to his language and the backgrounds of his works. Beidler

329. Shakespeare and Elizabethan Drama (3) fall
Study of the earlier plays of Shakespeare, mostly comedies and histories. Selected plays from contemporary dramatists such as Marlowe, Greene, and Jonson. Hook, Traister

330. Shakespeare and Elizabethan Drama (3) spring
Study of the later plays of Shakespeare, the tragedies and romances. Selected plays from contemporary dramatists such as Webster, Tourneur, Middleton. Hook, Traister

331. Milton (3) fall, 1983
Life and works of John Milton in connection with the history of his times and the chief sources of his inspiration. Greene

356. The Novel (3)
The novel as a literary form; selected novels from England, America, and the continent. Emphasis on a theme, period, or type.

360. Middle English Literature (3) spring, 1984
Major literary works of the Middle English period by authors other than Chaucer; some works in translation, some in the original. Emphasis on Langland, Gower, the Pearl Poet, and the metrical romances. Hartung

362. The Renaissance (3) fall, 1984
English nondramatic literature in the 16th century and the stimulus of the Italian Renaissance and northern humanism. Readings in and class discussions of the works of the chief writers: Petrarch, Erasmus, More, Wyatt, Surrey, Lyly, Sidney, and Spenser. Greene

364. The Seventeenth Century (3) spring, 1985
English literature of the 17th century, from Donne to Dryden. Traister

367. The Eighteenth Century (3) fall, 1983
Great British writers of the 18th century, beginning with the Restoration: Dryden, Pope, Swift, Defoe, Fielding and Johnson and his circle. James

369. British Romantic Literature (3) spring, 1984
Poetry and prose of Wordsworth, Coleridge, Byron, Shelley and Keats within the contemporary, political, religious and social context. Harson

371. British Victorian Literature (3) fall, 1984
Poetry and prose of Tennyson, Browning, Arnold, Swinburne, Carlyle, Mill, Newman, and Ruskin within the contemporary political, religious and social context. Bross

375. Major Authors (1-3)
The works of one or more major literary figures studied in depth. May be repeated for credit as title varies.

376. Early American Literature (3) spring, 1985
American literature to the Romantic period. Gallagher

377. American Romanticism (3)
The chief American Romantics: Emerson, Thoreau, Whitman, Hawthorne, Melville and Dickinson. The European and American philosophical, historical, and social background as well as the aesthetic study of romantic masterpieces. Arbur, DeBellis

378. American Realism (3) fall, 1984
Theory and practice of realistic fiction from the Civil War to the early 20th century: Twain, Howells, James, Norris, Crane, Chopin, Dreiser, and others. Frakes

379. Twentieth-Century American Literature (3) spring, 1984
American literature before World War II. Lectures and class discussion of major fiction and poetry. DeBellis, Mundhenk

380. Contemporary American Literature (3) fall, 1984
American literature since World War II. Lectures and class discussions of new writers and of recent works of established writers. DeBellis, Frakes

382. Themes in American Literature (3) fall, 1983
Intensive study of one topic in American literature. Readings from the colonial period to the present. May be repeated for credit as topic varies. Frakes

383. Modernism and Post-Modernism in Fiction (3), spring, 1985
The "anti-realistic" novel; time/space, point of view, narrative voice, structure as meaning. Kafka, Woolf, Beckett, Nabokov, Robbe-Grillet, Faulkner, Borges, Hawkes, Stein. Frakes

385. Twentieth-Century World Literature (3) fall, 1983
World English literature and continental literature before World War II. Lectures and class discussion of major fiction and poetry.

386. Contemporary World Literature (3) spring, 1984
World English literature and continental literature since World War II. Lectures and class discussions of new writers and of recent works by established writers. Frakes

391. Special Topics (1-3)
A topic, genre, or approach in literature or writing not covered in other courses. Prerequisite: six hours of freshman English.

Graduate Courses in English

The following courses are seminars, ordinarily limited to no more than twelve graduate students, but undergraduate English majors who are planning to go on to graduate school in English and who have shown proficiency in the study of literature may petition to take one of these seminars in their senior year.

421. History of the English Language (3) fall, 1983
The phonology, grammar and lexicon of English from the beginnings to the present. Vickrey

423. Old English (3) fall, 1984
Old English language and literature. Vickrey

424. Beowulf (3) spring, 1985
The Beowulf poem and some of the pertinent scholarship. Vickrey

427. Chaucer (3)
The life and works of Chaucer. Readings, reports and discussions. Hartung

428. Chaucer (3)
Continuation of Engl 427. Hartung

429. Middle English Metrical Romances (3)
Middle English non-Arthurian verse romances. Hartung

431. Arthurian Literature of the Middle Ages (3)
Arthurian literature from its Celtic beginnings to Malory's *Morte D'Arthur.* Hartung

433. Middle English Literature (1-3)
A topic, a genre or a grouping of works or authors in the Middle English period. Sample offerings: The Medieval Humorous Tale; Medieval Drama. May be repeated as title varies. Beidler

439. Sixteenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the 16th century. Sample offerings: 16th Century Drama, Spenser. May be repeated for credit as title varies. Hook, Traister

441. Seventeenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the 17th century. Sample offerings: Jacobean and Caroline Drama; Metaphysical Poetry. May be repeated for credit as title varies. Hook, Traister

443. Eighteenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the 18th century. Sample offerings: The Rise of the Novel; Boswell, Johnson, and their circle. May be repeated for credit as title varies. James, Fergus

445. Nineteenth-Century British Literature (1-3)
A topic, a genre, or a grouping or works or authors in the Romantic or Victorian periods. Sample offerings: Wordsworth and Byron; The Victorian Novel. May be repeated for credit as title varies. Bross, Harson, Mundhenk

449. Twentieth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in 20th century literature of the British Isles. Sample offerings: Conrad; Joyce. May be repeated for credit as title varies. Frakes, Greene

471. Early American Literature (3)
A topic, a genre, or a grouping of works or authors of colonial America or the early republic. Sample offerings: The Roots of the American Dream; Science and Religion in the Colonial Period. May be repeated for credit as title varies. Gallagher

473. American Romanticism (3)
A topic, a genre, or a grouping of works or authors in the American Romantic period. Sample offerings: The Nature of Evil in Hawthorne; Melville and Poe. May be repeated as title varies. Arbur, DeBellis

475. American Realism (3)
A topic, a genre, or grouping of works or authors in American literature from the Civil War to World War I. Sample offerings: James; American Literary Naturalism. May be repeated for credit as title varies. Frakes

477. Modern American Literature (3)
A topic, a genre, or a grouping of works or authors in the literature written after World War I. Sample offerings: Hemingway and Faulkner; Southern Writers. May be repeated for credit as title varies. DeBellis, Frakes

481. Literary Criticism (3)
Theory and practice of criticism. The nature and function of literature itself, the assumptions and methodologies of major 20th century critical "schools," and similar topics, regarded as objects of knowledge and as models for students' own critical reading, writing, and teaching. May be repeated for credit as title varies. Arbur

485. Teaching of College English (3)
History, theory, and practice of teaching the freshman composition course. Required of all new teaching assistants in the department of English. May be rostered by others only with consent of the department chairperson.

489. Workshop for English Teachers (1-3)
Study of a body of information with particular emphasis, through reports and discussion, on how the information can best be taught to secondary and college students. Sample topics: Shakespeare for Teachers; Teaching the Novel: Teaching Poetry. May be repeated for credit as topic varies.

491. Special Topics (1-3)
Selected topics in the field of English not covered in other courses. May be repeated for credit as topic varies. Prerequisite: consent of the director of graduate studies.

493. Graduate Seminar (3)
Intensive study of the works of one or more authors, or of a type of literature, or of the teaching of an author or a type of literature. May be repeated for credit as topic varies.

495. Independent Study (3)
Independent study in approved areas. To be rostered by candidates for the master of arts degree in English who desire to take an examination on selected figures rather than submit a thesis. Prerequisite: consent of the director of graduate studies.

Environmental Sciences and Resource Management

Edward B. Evenson, Ph.D., *director,* environmental sciences and resource management and associate professor of geological sciences.
Concentration advisers: Jon I. Parker, Ph.D., biology; Robert S. Sprague, Ph.D. chemistry; Sharon M. Friedman, M.A., environmental science writing; Edward B. Evenson, Ph.D., geology.

Society's increasing demands for energy, water, mineral commodities, food, recreational and living space have altered and will continue to alter the global ecosystem. The need for personnel trained to evaluate proposed alterations and to repair existing deleterious or critical situations can best be met by an interdisciplinary approach. Additionally, there is a pressing need to communicate about environmental problems at all levels of society, from the scientist to the layman. Writing about the environment can best be done by persons trained in both science and communication skills.

Environmental sciences and resource management is an interdepartmental major fostering basic preparation for advanced study or an immediate career in environmental management, conservation and environmental science writing. The backgrounds of fundamental mathematics and science required to understand the interactions of humans and their environment are established early in the major where the student is exposed to the core courses of mathematics, chemistry, physics, biology and geology.

Following this basic preparation, students select a concentration area within which more advanced training is undertaken. Concentrations in biology, chemistry, geology and environmental science writing have been established and concentrations in other fields can be designed to meet the needs and career desires of individual students.

Student research in specific problems involving laboratory, field, library or mass media research is an intergral part of the program and is strongly encouraged.

Graduates of this major can expect to take part in planning, education, research and coordination of environmental programs for all levels of government and industry. Those concentrating in environmental science writing also can pursue careers in science journalism or in professions such as environmental law or environmental management, where communication skills are highly desired. Graduate study is advisable for students wishing to pursue a career in most aspects of environmental science and the program provides thorough preparation for advanced training in environmental science or concentration areas.

Major Requirements

The program requires 120 credit hours. Credit is allocated as follows: 36 credits for college and university

requirements, 66 credits in preliminary courses, and 18 credit hours in the area of concentration.

college and university requirements (36 credit hours)

Engl 1	Composition and Literature (3)
Engl 2, 4, 6, 8, 10 **or** 16	Composition and Literature (3)
	general electives (30)

Note: General elective courses are non-professional courses designed to give the student a broad understanding in traditional and contemporary fields of thought outside of natural science and mathematics. The elective program (30 hours minimum) shall include at least twelve hours of humanities and twelve hours of social sciences.

required preliminary courses (66 credit hours)

Math 21	Analytical Geometry and Calculus I (4)
Math 22	Analytical Geometry and Calculus II (4)
Math 23	Analytical Geometry and Calculus III (4)
Phys 11	Introductory Physics I (4)
Phys 12	Introductory Physics Laboratory I (1)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Chem 21	Introductory Chemical Principles (4)
Chem 22	Chemical Principles Laboratory (1)
Chem 23 **or**	Analytical Environmental Chemistry (3) **or**
Chem 31	Chemical Equilibria of Aqueous Systems (3)
Chem 51	Organic Chemistry (3)
Chem 53	Organic Chemistry Laboratory (1)
Geol 21	Principles of Geology or Geol 101 (3)
Geol 22	Introductory Geology Laboratory (1)
Geol 32	Historical Geology and Stratigraphy (3)
Geol 133	Introductory Mineralogy and Petrology (3)
Geol 11	Environmental Geology (3)
Biol 21	Principles of Biology (3)
Biol 22	Introduction to Biology Laboratory (1)
Biol 151	Vertebrate Field Biology (3)
Biol 306 **or**	Ecology (3) **or**
Biol 309	Aquatic Biology
Biol 303	Invertebrate Zoology (3)
Eco 311 **or**	Environmental Economics (3) **or**
Eco 314	Energy Economics
Journ 123	Basic Science Writing (3)

Concentrations

Eighteen credit hours required. Students should select and fulfill one of the following areas of concentration. The courses in each concentration area have been recommended and approved by the respective departments.

Geology Concentration

Geol 123	Structural Geology (3)
Geol 312	Geomorphology (3)
Geol 313	Sedimentology (3)
Geol 333	Crystallography (3)
Geol 341	Field Camp (6)

Biology Concentration

Biol 28	Genetics (3)
Chem 52	Organic Chemistry (3)
Biol 135	Microbiology (3)
Biol 322	Animal Physiology (3)
Biol 332	Vascular Plants (3)
Biol	Approved Field Course (3)

Chemistry Concentration

Chem 52	Organic Chemistry (3)
Chem 54	Organic Chemistry Lab (2)
Chem 187	Physical Chemistry (3)
Chem 191	Physical Chemistry (3)
Chem 234	Analytical Chemistry Lab (1)
Chem 334	Chemical Oceanography (3)
Chem 332	Analytical Chemistry (3)

Environmental Science Writing Concentration

Journ 124	Politics of Science (3)
Journ 125	Environment, the Public and the Mass Media (3)
Journ 126	Writing About the Environment (3)
Journ 133	Editing (3)
Journ 113	Special Topics in Science Writing (3)
Journ 17 **or**	Magazine Article Writing (3) **or**
Journ 114 **or**	Reporting of Public Affairs (3) *or*
Journ 312	Advanced Science Writing (3)

Recommended Sequence of Courses

freshman year, first semester (15 credit hours)

Math 21	Analytic Geometry and Calculus I (4)
Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Engl 1	Composition and Literature (3)
	general elective (3)

freshman year, second semester (14 credit hours)

Math 22	Analytical Geometry and Calculus II (4)
Geol 21, 22	Principles of Geology and Laboratory (4)
Engl 2, 4, 6, 8 **or** 10	Composition and Literature (3)
	general elective (3)

sophomore year, first semester (16 credit hours)

Math 23	Analytical Geometry (4)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Biol 21, 22	Principles of Biology and Laboratory (4)
Geol 11	Environmental Geology (3)

sophomore year, second semester (14 credit hours)

Phys 21, 22	Introductory Physics II and Laboratory (5)
Geol 32	Historical Geology and Stratigraphy (3)
	general elective (3)
	concentration course (3)

junior year, first semester (16 credit hours)

Chem 51, 53	Organic Chemistry and Laboratory (4)
Geol 133	Introductory Mineralogy and Petrology
Biol 151	Vertebrate Field Biology
	concentration course (3)
	general elective (3)

junior year, second semester (15 credit hours)

Chem 23 **or**	Analytical Environmental Chemistry (3) *or*
Chem 31	Chemical Equilibria of Aqueous Systems (3)
Biol 306	Ecology (3)
	concentration course (3)
	general elective (3)
	general electives (6)

summer

Geol 341	Field Camp (6). Geology concentration only.
Biol	Approved field course (3). Biology concentration only.

senior year, first semester (15 credit hours)

Biol 303	Invertebrate Zoology (3)
	concentration course (3)
	general electives (6)
Journ 123	Basic science writing

senior year, second semester (15 credit hours)

CE 371	Environmental Health Engineering (3)
	concentration courses (6)
	general electives (6)
Econ 311 or	Economics of Resource use (3) *or*
Econ 314	Energy Economics (3)

Fine Arts

See listings under Art and Architecture.

Five-Year Programs

There are a number of ways in which students can obtain two degrees in five years of study. See listings under Arts-Engineering; Arts-Master of Business Administration; Civil Engineering and Geological Sciences; Electrical Engineering and Engineering Physics; and Engineering-Master of Business Administration.

Foreign Culture And Civilization

See listings under Modern Foreign Languages.

Foreign Literature

See listings under Classics and under Modern Foreign Languages.

French

See listings under Modern Foreign Languages.

Foreign Careers

Alvin Cohen, professor of economics and *director,* Foreign Careers program.

This major in the College of Arts and Science is designed to meet the needs of the student who has decided upon an international business, law, or political focus for his education. It uses elements of the traditional liberal arts and business school curricula. Among those traditional liberal arts elements are courses in economics, government, history, international relations, and language. With respect to business school offerings, there are courses in accounting, finance, and statistics. The major also represents an excellent foundation for graduate study in business, law, and the social sciences.

Each student completes the courses in the common core, takes twelve credit hours from offerings in economics, government, history, international relations, and social relations as related to an area of geographical concentration, and eighteen credit hours in an area of functional concentration. Students should study the language related to their area of specialization.

Major Requirements

Common Core

(13 credit hours)

Eco 1	Economics (4)
Govt 3	Comparative Politics (3)
Math 21 or	Analytical Geometry and Calculus I (4) or
Math 41	BMSS Calculus (3)
Eco 145 or	Statistical Method (3) or
Math 7	Elements of Statistics (3) or
Psych 113	Psychological Research and Statistics (3)

Geographical Concentrations

(12 credit hours in one of the area listed)

Latin America, Europe, Russia, East Asia, the Middle East (select one)

The student selects four courses from the offerings of the relevant departments, with the consent of the director. A list of appropriate courses is lodged with the director.

Functional Options

(18 credit hours in one of the options listed)

International Business Concentration

Acctg 51 or	Essentials of Accounting (3) or
Acctg 108	Fundamentals of Accounting (3)
Eco 105	Microeconomic Analysis (3)
Eco 119	Macroeconomic Analysis (3)
Eco 229	Money and Banking (3)
Eco 339 or	International Trade (3) or
Eco 303	Economic Development (3)
Eco/Fin 340	International Finance (3)

Public Administration Concentration

Acctg 51 or	Essentials of Accounting (3) or
Acctg 108	Fundamentals of Accounting (3)
IR 353 or	International Institutions (3) or
IR 361	International Law (3)
Eco 353	Public Finance (3)
Govt 360	Public Administration (3)
Govt 306	Public Policy Process (3) or
Govt 355	Public Personnel (3)
Govt 322	Politics of Developing Nations (3) or
Eco 303	Economic Development

Open Option Concentration

With the consent of the director, the student may combine eighteen credit hours more flexibly than is the case with either the international business or the public administration option.

Fundamental Sciences

Curtis W. Clump, *associate dean* of the College of Engineering and Physical Sciences, *director* of the fundamental sciences program.

The curriculum in fundamental sciences is designed to enable students to achieve a breadth of academic background in the fields of modern science and at the same time, through an option, to master the discipline of one of them, approximately to the level of a minimum bachelor's program. The options and electives provide sufficient flexibility to enable a student to prepare for employment in industry or government or approach adequacy for graduate study in a field.

The program offers an opportunity for students who are uncertain of their desire for a career in a particular field to proceed on a broad program that can lead to a bachelor's degree. If the student's interest crystallizes in an established field, transfer to that major will normally be possible with only a minimum of dislocation especially if the student has completed the introductory courses in that field.

Fundamental science students are required to concentrate in a major. Students can organize acceptable programs including the substantive course elements related to any one among several areas such as chemistry, physics and mathematics, biology, earth and space science, science of living systems, materials, computer science, and architecture, or meaningful combinations of any two.

The freshman year is identical with that of all students in the College of Engineering and Physical Sciences. The General Studies requirements of the college must also be satisfied. The discipline of a field will be provided by the inclusion of at least fifteen semester hours or from a combination that constitutes the core of one of the combination fields. Examples of these combination majors include: biochemistry, geophysics, bioengineering, applied mathematics, biophysics, and computer science. Students pursuing double concentrations may, with the approval of their adviser, substitute for one of the science courses of the sophomore year a basic course in the area of concentration.

The details of the student's program are worked out by the student with the advice of the curriculum adviser, and with the approval of the department chairperson concerned with the fields of concentration.

Recommended Sequence of Courses

freshman engineering year (see page 46)

sophomore year, first semester (15-16 credits)

Biol 21, 22 *or*	Principles of Biology and Laboratory (4) *or*
Geol 1	Principles of Geology (3)
Chem 51, 53	Organic Chemistry and Laboratory (4)
Math 23	Analytical Geometry and Calculus III (4)
Eco 1	Economics (4)

sophomore year, second semester (17 credits)

	major subject (3)
	approved elective (3)
Math 205	Linear Methods (3)
Phys 21, 22	Introductory Physics II and Laboratory (5)
	General Studies elective (3)

junior year, first semester (15-16 credit hours)

Geol 1 *or*	Principles of Geology (3) *or*
Biol 21, 22	Principles Biology and Laboratory (4)
Psych 1	Introduction to Psychology (3)
Math 231	Probability and Statistics (3)
	major (3)
	General Studies elective (3)

junior year, second semester (15 credit hours)

	approved electives (6)
	major (6)
	elective (3)

senior year, first semester (15-18 credit hours)

	approved electives (6)
	major (6)
	General Studies elective (3)
	elective (0-3)*

senior year, second semester (15-18 credits)

Phil 261	Philosophy of science (3)
	approved elective (3)
	major (6)
	General Studies elective (3)
	elective (0-3)*

*Please refer to description of normal program, page 46.

Geological Sciences

Professors. Charles B. Sclar, Ph.D., *chairperson;* Bobb Carson, Ph.D.; Paul B. Myers, Jr., Ph.D.; James M. Parks, Ph.D.; J. Donald Ryan, Ph.D.; Dale R. Simpson, Ph.D.
Associate professor. Edward B. Evenson, Ph.D.
Assistant professors. Kenneth P. Kodama, Ph.D.; Terry L. Pavlis, Ph.D.

Geology and related sciences such as geophysics and geochemistry deal with natural phenomena on or within the earth. Each makes use of other more fundamental sciences in its practice; hence, the student preparing for a career in one of the geological sciences combines study in geology with a broad understanding of physical, chemical, and biological principles.

Lehigh offers two undergraduate programs in geological sciences, one leading to the degree of bachelor of science in geological sciences, the other to the degree of bacelor of arts. The bachelor of science curriculum is considered to be the professional route. The bachelor of arts program requires fewer credits for graduation (121 vs. 127 credit hours), fewer courses in collateral sciences and mathematics (34 vs. 37 credit hours), and fewer geology courses (32 vs. 42 credit hours). Candidates for the bachelor of science degree also are required to take fifteen credit hours in approved professional electives. The professional electives permit the student to arrange for an informal option in geophysics, geochemistry, engineering geology, etc.

Students electing the bachelor of arts program are required to meet the distribution requirements of the College of Arts and Science; candidates for the bachelor of science degree take thirty credit hours of nonprofessional electives in place of the distribution requirements. There is no foreign language requirement in either program. However, it is strongly recommended that all students who plan to attend graduate school and who have not previously studied either French, German, or Russian include courses in one of these languages in their undergraduate program.

Both the bachelor of science program and the bachelor of arts program provide preparation for graduate school. Qualified students may be given permission at the end of the junior year to enter a program wherein they are able to begin work toward a graduate degree during the senior year. (See Combined B.A. or B.S. and M.S. program below.)

Geological training may be utilized in industry (especially in the petroleum, mining, highway construction, ceramics, and metallurgical industries), government service, natural resource management, and in secondary school, college, and university teaching. Students planning on careers in industry are advised to register for the bachelor of science program.

A major in geophysics is offered with faculty from cooperating departments. This program is described under "Geophysics."

Major Requirements for B.S.

A total of 127 credit hours is required.

college and university, requirements (36 credit hours)

Engl 1	Compositon and Literature (3)
Engl 2, 10, 14 or 16	Composition and Literature (3)

electives (30 credit hours)

Elective courses are nonprofessional courses designed to give the student a broad understanding in traditional contemporary fields of thought outside of natural science and mathematics. The courses are chosen by the student. The elective program includes a minimum of 12 credit hours in the humanities and a minimum of 12 credit hours in the social sciences as defined by the faculty for the bachelor of arts.

major program (91 credit hours)

mathematics (12 credit hours)

Math 21	Analytical Geometry and Calculus I (4)
Math 22	Analytical Geometry and Calculus II (4)
Math 23	Analytical Geometry and Calculus III (4)

collateral sciences (22 credit hours)

Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Chem 31	Chemical Equilibria in Aqueous Systems (3)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Phys 21, 22	Introductory Physics II and Laboratory (5)
Biol 21, 22	Principles of Biology and Laboratory (4)

geology (42 credit hours)

Geol 21	Principles of Geology (3)
Geol 22	Introductory Geology Laboratory (1)
Geol 111	Computer Applications (1)
Geol 31	Historical Geology (3)
Geol 123	Structural Geology (3)
Geol 133	Introductory Mineralogy and Petrology (3)
Met 210	Metallurgical Thermodynamics (3) *or*
Chem 187	Physical Chemistry (3)
Geol 301	Introduction to Geophysics (3)
Geol 311	Paleontology (3)
Geol 312	Geomorphology (3)
Geol 313	Sedimentology (3)
Geol 333	Crystallography (3)
Geol 334	Petrology and Petrography (4)
Geol 341	Field Geology (6)

Note: Before taking Geol 341, it is recommended that a student complete Geol 21, 22, 31, 123, 133, 312, and 313.

approved professional electives (15 credit hours)
Courses approved to fulfill this requirement should form a coherent package supporting the professional objectives of the student. Examples of coherent groups of recommended courses that may serve to fulfill this requirement are as follows:

Geol 336	Mineral Phase Relations (3)
Geol 337	X-ray Methods (3)
Geol 338	Electron Metallography (4)
Geol 357	Economic Geology (3)
Geol 372	Principles of Geochemistry (3)
Geol 314	Glacial and Quaternary Geology (3)
Geol 319	Regional Stratigraphy (3)
Geol 321	Statistical Applications (3)
Geol 327	Genesis of Carbonate Rocks-1 (1)
Geol 328	Genesis of Carbonate Rocks-II (2)
Geol 397	Soil Genesis (3)

Other coherent groups of courses that meet the specific objectives of the individual student may be selected with the approval of the faculty adviser.

Recommended Sequence of Science Courses

freshman year

Geol 21, 22	Principles of Geology and Laboratory (4)
Geol 31	Historical Geology (3)
Math 21, 22	Analytical Geometry and Calculus I and II (8)
Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Phys 11, 12	Introductory Physics I and Laboratory (5)

sophomore year

Geol 123	Structural Geology (3)
Geol 133	Introductory Mineralogy and Petrology (3)
Geol 111	Computer Applications (1)
Math 23	Analytical Geometry and Calculus III (4)
Phys 21, 22	Introductory Physics II and Laboratory (5)
Chem 31	Chemical Equilibria in Aqueous Systems (3)

junior year

Geol 312	Geomorphology (3)
Geol 313	Sedimentology (3)
Geol 333	Crystallography (3)
Geol 334	Petrography (4)
Biol 21, 22	Principles of Biology and Laboratory (4)
Met 210 *or*	Thermodynamics or Physical or
Chem 187	Chemistry (3)

summer following junior year

Geol 341	Field Geology (6)

senior year

Geol 301	Introduction to Geophysics (3)
Geol 311	Paleontology (3)

five professional electives (15)

B.A. with Geology Major

A total of 121 credit hours is required.

college and university requirements

Engl 1	Composition and Literature (3)
Engl 2, 10, 14 or 16	Composition and Literature (3)

distribution requirements (see page 37)

major program (66 credit hours)
mathematics (12 credit hours)

Math 21	Analytic Geometry and Calculus I (4)
Math 23	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)

collateral sciences (22 credit hours)

Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Chem	approved elective (3)
Phys 11,12	Introductory Physics I and Laboratory (5)
Phys 21, 22	Introductory Physics II and Laboratory (5)
Biol 21, 22	Principles of Biology and Laboratory (4)

geology (32 credit hours)

Geol 21	Principles of Geology (3)
Geol 22	Introductory Geology Laboratory (1)
Geol 111	Computer Applications (1)
Geol 31	Historical Geology (3)
Geol 123	Structural Geology (3)
Geol 133	Introductory Mineralogy and Petrology (3)
Geol	approved electives (12)
Geol 341	Field Geology (6)

Geology Minor

A minor in geological sciences may be achieved by completing the following requirements:

Geol 21, 22	Principles of Geology and Laboratory (4)
Geol 31	Historical Geology (3)
Geol 123	Structural Geology (3)
Geol 133	Introductory Mineralogy and Petrology (3)
geology elective	one 300-level course (3)

Combined B.A. or B.S. and M.S. Program in Geological Sciences

The department of geological sciences offers a combined bachelor of arts or bachelor of science and master of science program. Students working toward the bachelor of arts or the bachelor of science in geological sciences who are enrolled in this program are permitted to take courses that apply toward the master of science degree during their senior year. During the student's senior year, the normal undergraduate tuition will cover the costs of all courses taken including those that are taken for graduate credit.

After receiving the bachelor's degree, students registered in the program may acquire, if eligible for admission to The Graduate School, full-time graduate status, and, as such, they may apply for appointment to a teaching or research assistantship or graduate fellowship.

The program is designed for those students who, upon completing the junior year and the field camp requirement, need less than thirty credit hours to complete work for the bachelor's degree. To be accepted into the program, students should have a superior record of academic performance.

Application for admission to the program should be made no later than the beginning of the first semester of the senior year and must be approved by the department faculty and the dean of The Graduate School. The application must include: a tentative master of science program approved by the department chairperson, and a roster, also approved by the department chairperson, showing which courses taken during the senior year apply toward the bachelor's degree and which courses apply toward the master's degree. No more than fifteen credit hours per semester may be rostered. A total of 151 credit hours are required for the combined bachelor of arts—master of science program and a total of 157 credit hours are required for the combined bachelor of science—master of science program. All of the normal requirements for each degree as outlined must be fulfilled.

Students enrolled in this program should make application for admission to full-time graduate status after completing the first semester of the senior year.

Program in Civil Engineering and Geological Sciences

The department of geological sciences, in conjunction with the department of civil engineering, administers a five-year program in geological engineering that leads to a bachelor of science degree in civil engineering and a bachelor of science degree in geological sciences. This is described under. Civil Engineering and Geological Sciences

Undergraduate Courses

11. Environmental Geology (3) fall
Analysis of the dynamic interaction of geologic processes and human activities. Catastrophic geologic processes, resource limitations and development, pollution of geologic systems, environmental legislation, engineering case studies. Evenson

21. Principles of Geology (3) fall-spring
Fundamental concepts of geology; the composition, structure, and development of the earth; processes of geological change. Lectures and field trip.

22. Introductory Geology Laboratory (1) fall-spring
Recommended laboratory given concurrently with Geol 1. Study of rocks and minerals, rock structures, land forms. Prerequisite: Geol 1 previously or concurrently.

111. Computer Applications (1) fall
The use of computers in the solution of geological problems. Introduction to Fortran; the use of published and available programs. Parks

31. Historical Geology and Stratigraphy (3) fall-spring
Origin and evolution of the earth and its parts: continents, ocean basins, hydropshere, and atmosphere; origin and evolution of life. Stratigraphic correlation, faces change, breaks in the record, paleogeographic and paleoenvironmental reconstruction. Lectures and laboratory work. Prerequisite: Geol 1 or 101. Ryan

123. Structural Geology (3) fall
The application of basic concepts of stress and strain and experimental data to study of the developments of faults, folds, and other deformational structures in the earth's crust. Introduction to the larger-scale problems of geotectonics. Prerequisite: Geol 1 or 101. Pavlis

133. Introductory Mineralogy and Petrology (3) fall
Principles of crystallography, mineralogy, and petrology; megascopic study, identification, and description of common minerals and rocks. Lectures and laboratory. Prerequisite: Geol 1 or 101, Chem 21. Sclar

63. Introduction to Oceanography (3) spring
A survey of the physical, chemical, biological, and geological nature of the oceans. Prerequisite: one year of science (biology, chemistry, geology or physics). Carson

101. Geology for Engineers (3) fall
A study of the materials that make up the earth, the physical, chemical, and environmental history that they relate, and the processes that act to change them. Designed primarily for upperclass science and engineering majors. Lectures and laboratory recitation. Myers

191. (Biol 191) Environmental Science Seminar (1) fall-spring
Seminar on current problems and developments in environmental science. May be repeated for credit. Prerequisite: sophomore standing. Evenson

For Advanced Undergraduates and Graduate Students

301. Introduction to Geophysics (3) fall
Application of physical principles to solution of crustal and near-surface geologic problems; reflection and refraction seismology, gravity, magnetic and electrical methods. Prerequisites: Math 21, Phys 21, and Geol 1 or 101. Kodama

302. Physics of the Earth (3) spring
Application of physical principles to the earth: origin, geochronology, heat generation and flux, seismology,

gravity, magnetism and tectonics. Prerequisites: Math 21, Phys 21. Kodama

306. Geophysical Field Techniques (3) spring
Geophysical field investigation in an area of geological interest. Theory and application of seismic, gravity, magnetism, and electrical methods; data collection, interpretation, and a written report. Individual assignments of a geophysical field in an area of geological interest. Prerequisite: Geol 301 or consent of department chairperson. Kodama

310. Introduction to Plate Tectonics (3) fall
Theory of plate tectonics with emphasis on plate geometry, geophysical relationships and geological consequences. Lectures and laboratory. Prerequisites: Geol 21 and 22 or 101, and Physics 21. Kodama, Pavlis

311. Paleontology (3) spring
Morphology of invertebrate fossils, their use in interpreting geologic history; evolution of the faunas and floras. Lectures and laboratory work. Prerequisite: Biol 21. Parks

312. Geomorphology (3) spring
Systematic study of the origin, evolution, and distribution of the earth's topographic features, land forms analyzed in terms of chemical and physical processes responsible for their development. Lectures and required field trips. Prerequisite: Geol 21 or 101. Evenson

313. Sedimentology (3) fall
The processes that control weathering, transportation, and deposition of sediments; the characteristics of sediments and environments of deposition. Lectures and laboratory. Carson

314. Glacial and Quaternary Geology (3) fall
Study of the origin, distribution, and movement of present and past glaciers. Special emphasis on glacial land forms and deposits, quaternary stratigraphy and dating techniques, periglacial phenomena, and Pleistocene environments. Lectures and required field trips. Prerequisite: Geol 21 or 101 or consent of department chairperson. Evenson

317. (Biol 317) Evolution (3)
The origin of species and higher categories with emphasis on animals. Isolating mechanisms, population structure, rates of evolution, extinction. Prerequisite: two semesters of biology or consent of department chairperson. Barber

319. Stratigraphy and Basin Analysis (3) spring
Ancient sedimentary basins: use of surface and subsurface methods of stratigraphic analysis in paleoenvironmental and paleogeographic reconstruction. Facies and facies change, tectonics and sedimentation, paleocurrent patterns, correlation, sedimentary sequences and cycles; and stratigraphic nomenclature. Prerequisite: Geol 31. Ryan

320. Advanced Computer Applications (1-3) spring
Independent investigation of special problems utilizing computer techniques. Prerequisite: Geol 111 or consent of the department chairperson. Parks.

321. Statistical Applications (3) fall
Statistical models applicable to geological, geochemical, and geophysical field and laboratory studies. Analysis of variance, applications of the chi-square distribution, analysis of covariance, linear, nonlinear and multiple regression, and distribution-free methods. Carson

323. Geophysics of Plate Tectonics (2) fall
Seminar on geophysical topics in plate tectonics: geometry, seismology, magnetism, gravity, driving mechanism, heat flow. Prerequisites: Geol 123 and Phys 21. Kodama

327. Genesis of Carbonate Rocks I (1) fall
Seminar on the geology and biology of modern and ancient carbonate environments: biology and ecology of major carbonate producing organisms; origin, deposition, lithification and classification of carbonate sediments. Student-faculty seminars and discussions. Evenson, Parks

328. Genesis of Carbonate Rocks II (2) spring
Field studies carried out in intersemester period (January) in Florida Keys on modern and ancient carbonate environments: ecology and geology of reef-building corals, calcareous algae, and other carbonate-producing organisms in beach, reef, lagoonal, and traditional environments. Team research projects and reports. Evenson, Parks

333. Crystallography (3) fall
Fundamentals of crystallography and crystal structure; patterns and symmetries, symmetry notations, crystal morphologies and internal structure, principles of crystal chemistry. The anisotropy of crystalline materials with special reference to crystal optics. Lectures and laboratory. Prerequisite: Geol 133, previously or concurrently. Simpson

334. Petrology and Petrography (4) spring
Evolution of rocks and their distribution in space and time; Microscopic study of rocks. Lectures, laboratory work, and field trips. Prerequisite: Geol 333. Myers

336. Mineral Phase Relations (3) spring
Principles of phase equilibria; unicomponent and multicomponent condensed systems and multicomponent systems with volatile phases. The application of phase relation studies to mineralogical and geological problems. Prerequisite: Geol 333. Lectures and laboratory. Simpson

337. (Met 333) X-ray Methods (3) fall
Fundamentals and experimental methods of X-ray techniques. Application to various materials problems including diffraction, radiography, fluorescent analysis. Lectures and laboratory work. Prerequisite: Phys 21, Met 91 or equivalent. Conard, Kraft

338. (Met 334) Electron Metallography (4) spring
Fundamentals and experimental methods in electron optical techniques included scanning electron microscopy (SEM) conventional transmission (TEM) and scanning transmission (STEM) electron microscopy. Specific topics covered will include electron optics, electron beam interactions with solids, electron diffraction and chemical microanalysis. Applications to the study of the structure of materials are given. Prerequisite: consent of the department chairperson. Williams, Goldstein

341. Field Geology (6) summer
Field study and geologic mapping of sedimentary, igneous-metamorphic, and glacial deposits in the Rock Mountains of northwestern Wyoming, and southeastern Idaho. Additional short studies in the Badlands and Black Hills of South Dakota, the Grand Tetons, Yellowstone Park, Craters of the Moon Park, and other areas in the Rocky Mountain region. Six weeks in the field. Summer session. Prerequisite: consent of the department chairperson. Graduate credit not given for this course. Evenson, Myers

344. Structural Evolution of North America (3) spring
Structural elements of North America and their geological evolution within the framework of global tectonics. Prerequisites: Geol 21 and 22 or 101, 31, and 123. Pavlis

346. Case Histories in Engineering Geology (3) spring
Methods of geological investigation at engineering sites. Assessing suitability of a proposed site, acquiring geological information for proper engineering design, and recognizing potential geotechnical problems during

and after construction. Prerequisites: Geol 21 and 22 or 101. Myers

351. Petroleum Geology (3)
Origin, migration, and accumulation of petroleum and natural gas; general principles of exploration and production. Prerequisites: Geol 123 and Geol 313 previously or concurrently. Parks

352. Applied Mineralogy (3)
Methods and approaches to the solution of industrial and environmental problems employing modern mineralogical techniques, especially transmitted-and incident-light polarizing microscopy and X-ray powder diffraction. Case histories of interest to geologists, chemists, ceramists, chemical, metallurgical, and mineral engineers, environmental engineers, and materials scientists. Lectures and laboratory. Prerequisite: Geol 333 or consent of the department chairperson. Sclar

355. Soil Genesis (3) fall
A geologic approach to the genesis, classification and application of pedology. Weathering of parent materials; chemistry of soils; geologic, biologic, and climate controls on soil formation; geologic and engineering geologic applications of soils. Field and laboratory investigations will acquaint the student with modern analytic techniques. Two lectures and one laboratory/discussion per week. Prerequisites: Geol 313 or consent of the department chairperson. Evenson, Carson, Myers

356. Ground Water (3) fall
The geology and geochemistry of ground water. Techniques used in prospecting for ground water, ground water law, management and conservation, evaluation and planning. Prerequisites: Chem 21, 22, Geol 23. Myers

357. Economic Geology (3) spring
The formation of mineral deposits and the occurrence and characteristics of deposits of economic importance. Includes metals, nonmetals and fuels. Lectures, laboratory work and inspection trips. Prerequisite: Geol 1. Simpson

358. Modern Depositional Environments (3) spring
Characteristics and distribution of sedimentary facies in diverse sedimentary environments. Processes and patterns of alluvial, glacial, desert, lacustrine, deltaic, neritic, and pelagic deposition. Facies as tectonic indicators. Prerequisite: Geol 313 or equivalent. Carson

372. Principles of Geochemistry (3) spring
Synthesis of the geological, chemical, physical, and astronomical observations regarding the geochemical evolution of the earth, its internal constitution, and the physico-chemical processes which modify the crust. Crystal-chemical controls on the abundance and pressure studies of geochemical significance. Shock metamorphism as a geochemical process on the surface of the earth, moon and planets. Sclar

For Graduate Students

The graduate program in geological sciences is directed principally toward the study of geologic processes. Candidates for the master's degree receive instruction in most fields of geology and are expected to take courses in appropriate collateral fields of science. Advanced graduate students, working toward the doctorate, specialize in one field of geoscience.

Research is an important part of the graduate program. In general, students are encouraged to choose research problems that for their solution require the use of intergrated laboratory and field studies.

Candidates for the master of science degree are required to complete a thesis (six credit hours) that must be presented in the form specified by The Graduate School. The research for and writing of the thesis will be done under the direction of the thesis director who must be a member of the department faculty. The thesis director and two other members will constitute the thesis committee for the master of science candidate. Students who enter the graduate program with a bachelor of science or bachelor of arts degree in geology and who wish to qualify for admission to candidacy, for the doctor of philosophy degree must take the departmental qualifying examination prior to the end of the fourth semester. Those who enter the program with a master of science degree must take the qualifying examination prior to the close of their second semester. Candidates entering the program from a discipline other than geoscience will be advised by the faculty when to take the qualifying examination.

Candidates for the doctor of philosophy degree must demonstrate through examination a thorough reading knowledge of one foreign language, generally French, German, or Russian.

Other requirements for graduate degrees are listed in The Graduate School section.

Special departmental research facilities of interest include; Philips APD-3600 automated X-ray powder diffractometer; Philips AXS automated X-ray fluorescence spectrometer, Debye-Scherrer X-ray powder cameras; complete petrographic and incident-light microscopy facilities; hydrothermal apparatus for experimental mineralogy; belt-type ultra-high-pressure apparatus for upper mantle studies; soft-sediment deformation apparatus; spark-source mass spectrometer; Sharples supercentrifuge; paleomagnetism laboratory with digitized spinner magnetometer and a Schonstedt tumbling XAC demagnetizer; Particle Data computer-based particle-size analyzer; Bison shallow refraction seismic unit; Wordon gravimeter; Geometrics portable proton precession magnetometer; Saltzman map projector; standard equipment for field mapping; a completely equipped marine geotechnical laboratory; and a portable rock drill.

Lehigh houses a station of the Pennsylvania Seismic Network that is equipped with a short-period vertical seismometer.

The following major analytical facilities are available on campus to students and staff of the department: fully automated JEOL 733 electron microprobe, Philips 300 electron microscope completely equipped for transmission and diffraction, ETEC scanning electron microscope with nondispersive analysis capability, Philips EM400, XTEM/STEM analytical electron microscope equipped for quantitative X-ray microanalysis and electron energy-loss spectroscopy; and Perkin Elmer double-beam infrared spectrophotometer.

405. The Earth's Magnetism (3) spring
Terrestrial magnetism, rock magnetism, history of the geomagnetic field, spherical harmonics, and the interpretation of magnetic anomalies. Prerequisite: Phys 21. Kodama

407. Seismology (3) fall
Basic seismological concepts: design and characteristics of seismometers; interpretation of seismograms; ray paths, body and surface waves, surface wave dispersion, earth structure, and free oscillations of the earth. Prerequisites: Math 23 and Phys 21. Kodama

411. Micropaleontology (3)
Classification, evolution, biometrics and paleoecology; study of fossil and modern populations and assemblages. Lectures and laboratories. Prerequisite: Geol 311. Parks

413. Advanced Topics in Sedimentology (1-3)
Study of the origin, dispersal, deposition, and diagenesis of sediments and sedimentary rocks. May be repeated for credit. Prerequisite: Geol 313. Carson

417. Sedimentary Petrography (3)
The theory and application of petrographic methods in the study and classification of sedimentary rocks. Prerequisite: Geol 334. Ryan

419. Sedimentary Basin Analysis (1)
Seminar on the use of directional features, petrographic variations, and other primary physical properties of sedimentary rock that make possible reconstruction of ancient sedimentary basins and sedimentary dispersal systems within such basins. May be repeated for credit. Ryan

421. Global Tectonics (3) fall
Topics include upper mantle composition and configuration, interrelations between the earth's crust and upper mantle, geophysical data related to hypotheses in global tectonics, continental drift and the plate model. Seminars and lectures. Pavlis

422. Regional Tectonics (3) spring
Concepts of global tectonics as applied to the geology of specific areas of the earth's crust. The tectonics of the Alpine-Himalayan chain, Rockies, Caledonides, Appalachian, coast ranges, and African Rift system are among subjects considered. Seminars and lectures. Pavlis

423. Sedimentary Geochemistry (3)
Processes controlling the distribution of elements in sediments and sedimentary rocks. Lectures, discussions, occasional laboratory exercises, and field trips. Ryan, Simpson

424. Advanced Structural Geology (3) alternate years
The theory and application of analytical methods in the study of rock deformation; experimental deformation, petrofabric analysis; statistical field methods. Myers, Pavlis

425. Seminar on Tectonics (1)
Seminar on contemporary topics in tectonics. May be repeated for credit. Myers

435. Advanced Mineralogy (3)
Topics of contemporary interest in mineralogy. Simpson

436. Advanced Mineralogy (3) offered as required
Similar to Geol 435. May be elected separately. Simpson

437. Advanced Igneous Petrology (3) alternate years
Origin of the diversity of igneous rocks as revealed by field and laboratory studies. Lectures, laboratory and field trips. Sclar

438. Advanced Metamorphic Petrology (3)
alternate years
Processes involved in the transformation of rock masses under high pressure and temperature. Problems of the deep crust and upper mantle. Lectures, laboratory and field trips. Sclar

439. Seminar on Petrology (1)
Critical review and assessment of current literature on major topics in petrology. May be repeated for credit. Sclar

442. Advanced Glacial Geology (3)
Seminar on advanced topics in glacial geology; review of classic and contemporary literature. Topics include dynamics of glacier movement, glacial landforms and deposits, glacial stratigraphy. Field trips. Prerequisite: Geol 314 or consent of the department chairperson. Evenson

444. (Biol 444). Multivariate Analysis (3) spring
The strategy of the applications of multivariate analysis techniques to problems in geology and biology. Analysis of larger data matrices by factor analysis, cluster analysis, discriminant function analysis, ordination and related techniques. Examples from both geology and biology. Prerequisites: Geol 10 and 321 or approved equivalents. Parks

446. Advanced Geomorphology (3)
Seminar on advanced topics in geomorphology. Field trips. Prerequisite: Geol 312 or consent of the department chairperson. Everson

454. Genesis of Metalliferous Deposits (3)
alternate years
Petrological concepts regarding the origin of metalliferous ore deposits. Laboratory includes ore-mineral synthesis, ore microscopy, and electron microprobe analysis of ores. Field examination of ore deposits at operating mines. Sclar

456. Advanced Topics in Economic Geology (3)
Modern concepts bearing on the nature and origin of ore deposits. Lectures, seminars, field trips. Simpson

461. Marine Geology (3) alternate years
Geology of the margins and the floors of the oceans. Carson

462. Paleoecology (3)
Reconstruction of paleoenvironments based on principles of paleoecology and sedimentary petrology. Prerequisites: Geol 311 and 313. Parks

471. High-Pressure Petrology (3)
High-pressure phase transformations, phase equilibria, and melting phenomena in multicomponent systems of petrological importance as applied to problems of the deep crust and upper mantle in the pressure range 15 to 150 kilobars at temperatures to 1500 degrees C. Effect of water as a free phase at high pressure. Lectures and laboratories. Sclar

472. Solution Geochemistry (3)
The processes of solution, transport, and deposition under hydrothermal conditions. Simpson

480. (Biol 480) Marine Science Seminar (1)
An advanced interdisciplinary seminar on various problems of marine sciences, with visiting speakers and student presentations.

481. Geological Investigation (1-6) fall-spring
Research on a special problem; field, laboratory, or library study; report required. Credit above three hours granted only when a different problem is undertaken.

482. Geological Investigation (1-6) fall-spring
Similar to Geol 481. Credit above three hours granted only when a different problem is undertaken.

490. Special Topics (1-6)
An extensive study of topics not covered in more general courses.

491. Special Topics (1-6)
Similar to Geol 490. may be elected separately.

Geophysics

Kenneth P. Kodama, assistant professor of geophysics, *director.*

Geophysics is the branch of the earth sciences in which physical principles are used to understand the subsurface geology and history of the earth. Geophysical methods are important both in the search for energy and mineral resources and in unravelling the past movements of the

tectonic plate mosaic over the earth's surface. The program is designed to provide the background needed for graduate work in geophysics or the preparation for employment in the petroleum and mineral industries.

Bachelor of Science Degree

One-hundred-twenty-six credit hours are required.

college and university requirements (36 credits)

Engl 1	Composition and Literature (3)
Engl 2, 10, 14, 16 (3)	
	electives (30 credit hours)

Elective courses are nonprofessional courses designed to give the student a broad understanding in traditional and contemporary fields of thought outside of natural science and mathematics. The courses are chosen by the student. The elective program includes a large number of courses broadly distributed among the various areas of the humanities and the social sciences.

major program (92-97 credit hours)

mathematics (18 credit hours)

Math 21	Analytical Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)
Math 205	Linear Methods (3)
Math 322	Methods of Applied Analysis I (3)

collateral sciences (eight credit hours)

Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Met 210 *or*	Metallurgical Thermodynamics (3) *or*
Phys 340	Thermal Physics (3)

physics (22 credit hours)

Phys 11	Introductory Physics I (4)
Phys 12	Introductory Physics Laboratory I (1)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Phys 190	Electronics (3)
Phys 212	Electricity and Magnetism I (3)
Phys 213	Electricity and Magnetism II (3)
Phys 215	Particles and Fields I (3)

geology (32 credit hours)

Geol 21	Principles of Geology (3)
Geol 22	Introductory Geology Laboratory (1)
Geol 31	Historical Geology (3)
Geol 111	Computer Applications (1)
Geol 123	Structural Geology (3)
Geol 133	Introductory Mineralogy and Petrology (3)
Geol 301	Introduction to Geophysics (3)
Geol 302	Physics of the Earth (3)
Geol 313	Sedimentation (3)
Geol 333	Crystallography (3)
Geol 341	Field Geology (6)

approved professional electives (12-17 credits)
Any courses approved by the adviser may be used to satisfy this requirement. The following are especially recommended:

Geol 310	Introduction to Plate Tectonics (3)
Chem 31	Chemical Equilibria in Aqueous Systems (3)
Geol 63	Introduction to Oceanography (3)
Geol 306	Geophysical Field Techniques (3)
Geol 319	Regional Stratigraphy (3)
Geol 321	Statistical Applications (3)
Geol 334	Petrology and Petrography (4)
Geol 336	Mineral Phase Relations (3)
Geol 372	Principles of Geochemistry (3)
Geol 381	Meteorology (3)
Math 323	Methods of Applied Analysis (3)
Math 105	Computer Programming (3)
Math 208	Complex Variables (3)
Math 309	Theory of Probability and its Applications (3)
Math 302	Vector and Tensor Anaylsis (3)
Math 366	Programming Techniques (3)
ME 231	Fluid Mechanics (3)
Met 91	Elements of Materials Science (3)
Phys 31	Introduction to Quantum Mechanics (3)
Phys 191	Laboratory Techniques (2)
Phys 216	Particles and Fields II (3)
Phys 340	Thermal Physics (3)
Phys 352	Modern Optics (3)
Phys 254	Optics Laboratory (2)
Phys 363	Physics of Solids (3)
Phys 365	Physics of Fluids (3)

German

See listings under Modern Foreign Languages.

Government

Professors. Howard R. Whitcomb, Ph.D., chairperson (on leave spring, 1983); Donald D. Barry, Ph.D.; Frank T. Colon, Ph.D.; W. Ross Yates, Ph.D.
Associate professors. Edward P. Morgan, Ph.D.; Laura Katz Olson, Ph.D.
Assistant professors. Jean C. Oi, Ph.D.; Robert C. Rickards, Ph.D.

A variety of experiential opportunities are available to undergraduates majoring in government. The department, for example, offers annually an "internship seminar" that includes opportunities for internship placements in either local government, private agencies or law offices. Students are also encouraged to apply for off-campus, internship opportunities offered under the auspices of American University's Washington Semester Program and the Harrisburg Urban Semester.

Completion of the government major is considered suitable training for the undergraduate who wishes to go on to law school, to become a social science teacher, or to work as a governmental official, party or civic leader, public affairs commentator, or staff member of a government research bureau. In addition, the business sector continues to provide opportunities in areas such as banking, insurance, and marketing for bachelor of arts graduates with training in the social sciences. Graduate study is advisable for students contemplating certain careers: college teaching, research, or public management, for example.

A variety of experiential opportunities are available to undergraduates majoring in government. The department, for example, offers annually an "internship seminar" that includes opportunities for internship placements in either local government, private agencies or law offices. Students are also encouraged to apply for off-campus, internship opportunities offered under the auspices of American University's Washington Semester Program and the Harrisburg Urban Semester.

Completion of the government major is considered suitable training for the undergraduate who wishes to go on to law school, to become a social science teacher, or to work as a governmental official, party or civic leader, public affairs commentator, or staff member of a government research bureau. In addition, the business sector continues to provide opportunities in areas such as

banking, insurance, and marketing for bachelor of arts graduates with training in the social sciences. Graduate study is advisable for students contemplating certain careers: college teaching, research, or public management, for example.

Major Requirements

Govt 1	American Political System (3)
Govt 3	Comparative Politics (3)
Govt 21	Introduction to Political Research (3)
Govt 102	Modern Political Heritage (3)

electives
Seven elective courses with at least two courses from each of the following two fields:

American politics, public law and interdisciplinary

Govt 77	Urban Politics (3)
Govt 174	Political Parties and Election (3)
Govt 179	The Politics of Women (3)
Govt 302	Comparative State Politics (3)
Govt 306	Public Policy Process (3)
Govt 315	Political and Social Forecasting (3)
Govt 317	The American Presidency (3)
Govt 327	Socialization and the Political System (3)
Govt 328	The Politics of Urban Education Policy (3)
Govt 331	Internship Seminar (3)
Govt 333	The Social Psychology of Politics (3)
Govt 351	Constitutional Law (3)
Govt 352	Civil Rights (3)
Govt 354	Administrative Law (3)
Govt 355	Public Personnel (3)
Govt 357	Technology Assessment (3)
Govt 359	The Legislative Process (3)
Govt 360	Public Administration
Govt 361	Field Research (3)

Political theory and comparative politics

Govt 101	Classical Political Heritage (3)
Govt 106	The Chinese Political System (3)
Govt 133	Political Violence (3)
Govt 161	The Soviet Political System (3)
Govt 171	Democracy (3)
Govt 308	Ideologies in World Affairs (3)
Govt 318	Communist Political Systems (3)
Govt 322	Politics of Developing Nations (3)
Govt 324	Political Systems in Transition (3)
Govt 325	International Political Economy (3)
Govt 363	Contemporary Political Philosophy (3)
Govt 364	Issues in Contemporary Political Philosophy (3)
Govt 368	Political Economy (3)

Government Minor

The minor consists of three of the four core courses listed above (Govt 1, Govt 3, Govt 21 and Govt 102) plus any two other government courses.

Public Administration Minor

The minor consists of Govt 1 and Govt 360 plus three other courses chosen in consultation with the adviser for a total of fifteen credit hours.

Undergraduate Courses

1. American Political System (3) fall-spring
Constitutional principles; organization and operation of the national government; the party system, citizenship, and civil rights.

3. Comparative Politics (3) fall-spring
The political systems of foreign countries; approaches to the study of comparative politics.

21. Introduction to Political Research (3) fall-spring
The research techniques of political science including research design, statistical and nonstatistical analysis, and computer applications.

77. Urban Politics (3)
The structure and processes of city government in the United States; city-state and federal-city relationships; the problems of metropolitan areas; political machines and community power structures; the urban politics of municipal reform; city planning and urban renewal. Colon

101. Classical Political Heritage (3)
Significant political theorists from Plato to modern times. Yates

102. Modern Political Heritage (3) fall-spring
Continuation of Govt 101, Classical political heritage. Utilitarianism, liberalism, socialism, idealism, positivism, etc.

106. The Chinese Political System (3)
Revolutionary origins of the Chinese political system. Roles of the state, structure, Communist Party, army, mass organizations, and political campaigns in the political decision-making and policy implementation processes. Nature and function of Chinese political ideology. Oi

133. Political Violence (3)
Potential forms and nature of political violence: especially civil unrest, terrorism, revolution, and war. Nature of conflict and its resolution.

161. The Soviet Political System (3)
The roles of the Communist Party, the Council of Ministers, the Supreme Soviet and other governmental and social organizations in governing the USSR. Barry

171. Democracy (3)
Theory and practice of democratic government in selected countries. Yates

174. Political Parties and Elections (3)
Organization, functions, and behavior of parties in the United States; voting behavior, campaigns, and elections. Colon

179. The Politics of Women (3)
Major social and political issues relating to the role of women in American society. Study of other countries will be included for comparative analysis. Olson

For Advanced Undergraduates and Graduate Students

302. Comparative State Politics (3)
Analysis of major questions relating to the role of the states in the American federal systems and their relationship with the national government. Colon

306. Public Policy Process (3)
Power relations and their impacts on selected public policy issues, specifically taxation, housing, environment, poverty, energy, the military, and health. Olson

308. (IR 308) Ideologies in World Affairs (3)
Theories of ideology; nationalism and imperialism; conservatism/liberalism/socialism; Marxism/Leninism/Maoism; fascism and militarism; Third World ideologies; current ideological trends. Wylie

313. Teaching Government (3)
Contemporary issues in the teaching of social studies in public and private schools, including those government decisions that affect the educational environment. The course focuses attention on a specific issue such as urban

problems, comparative political systems, ideologies and American political institutions and processes. Designed primarily for secondary school teachers.

314. Workshop in Teaching Government (3)
Individual research projects contemporary issues and discussion of proposals for curriculum revisions in the public and private schools. Outside speakers will be invited to attend workshop sessions. Must be taken concurrently with Govt 313 when courses are offered together.

315. Political and Social Forecasting (3)
An examination and evaluation of methods of forecasting, including an analysis of the relationships between technological, political, and social change. Topics will include energy, environmental, and demographic forecasting.

317. The American Presidency (3)
Role of the executive in the American political process. Includes an analysis of the historical development, selection process, and scope of executive power. Olson

318. (IR 318) Communist Political Systems (3)
Examination of Communist political systems outside the USSR and the operations of nonruling Communist parties.

322. (IR 322) Politics of Developing Nations (3)
Theories of political development in non-Western areas; modernization and nation building. Field studies and methods; contributions of related disciplines such as sociology and psychology. Oi

324. Political Systems in Transition (3) spring
The responses of selected non-Communist states to contemporary problems. Topics vary semester by semester. May be repeated for credit with consent of department chairperson.

325. (IR 325) International Political Economy (3)
Development of forms of political management of the world economy since World War II, with emphasis on control of interdependence among the industrialized countries, achievement of equity in relations between developed and developing countries, and reintegration of the centrally planned economies into the international economy. Hodges

327. Socialization and the Political System (3)
The social, ideological and economic foundations of American politics. Emphasis on supporting institutions—family, schools, and workplace—and processes that foster political attitudes and behavioral patterns. Morgan

328. (AdmS 328) The Politics of Urban Education Policy (3)
The interplay of political forces in selected urban policy areas. Readings, lectures and a class simulation to concentrate on: the roots of urban poverty; school desegregation, community control, fiscal reform; and the political role of community groups, government agencies, the courts, and social science. Morgan

331. Internship Seminar (3)
Integrated classroom and fieldwork approach to the study of local government; includes an internship in a local government or private agency. May be repeated for credit. Prerequisite: consent of the department chairperson. Morgan

333. (SR 333) The Social Psychology of Politics (3)
Political behavior viewed from a psychological and social psychological perspective.

351. Constitutional Law (3) fall
The law of the Constitution as expounded by the Supreme Court of the United States. Nature and origins of judicial review, distribution and scope of governmental powers, and economic regulation in a federal system. Detailed consideration of judicial policy decision-making processes. Whitcomb

352. Civil Rights (3) spring
A study of constitutional development in political and civil rights. Freedom of speech and of the press, religious freedom, due process of law and equal protection of the laws. Detailed consideration of constitutional issues concerning criminal procedure and racial discrimination. Whitcomb

354. Administrative Law (3)
The authority, procedures, and methods used by executive agencies in the administration of public policy. Analysis of the general problem of adjusting the administrative process to traditional constitutional principles. Barry

355. Public Personnel (3)
Problems in public personnel administration; the civil service and its reform; public employee unionism; due process within the organization; affirmative action; political neutrality of public servants. Barry

357. Technology Assessment (3)
Policy analysis of new and existing technologies in the United States; evaluation of societal consequences of technological decision-making and the identification of new alternatives in light of social needs.

359. The Legislative Process (3)
Organization and procedure of legislative and constituent assemblies. Legislative leadership. Role of administrative and judicial agencies in law-making. Pressure groups, parties, and policy determination. Direct legislation.

360. Public Administration (3)
The nature of administration; problems of organization and management; public personnel policies; budgeting and budgetary systems; forms of administrative responsibility. Colon

361. Field Research (3)
Application of basic research techniques to individual or small-group projects. Prerequisite: Govt 21 or consent of the chairperson.

363. Contemporary Political Philosophy (3)
Continuation of Govt 102 with concentration on political philosophers after World War I.

364. Issues in Contemporary Political Philosophy (3)
Selected issues in contemporary political philosophy, such as political obligation and civil disobedience, participatory democracy and workers' control, "positivist" political analysis and the alleged decline of political philosophy. May be repeated for credit with the consent of the department chairperson.

368. Political Economy (3)
Significance to democratic theory of the concentration of economic power and its interface with the polity.

371. Readings (1-3)
Readings in political science assigned to properly qualified students in consideration of their special interest in particular political institutions and practices. Prerequisite: consent of the departmental chairperson.

372. Readings (1-3)
Continuation of Govt 371. Prerequisite: consent of the department chairperson.

381, 382. Special Topics (3)
A seminar on a topic of special interest in a particular political institution process, or policy. Prerequisite: consent of the department chairperson.

For Graduate Students

The department of government offers a graduate program leading to the doctor of arts, the master of public administration, and the master of arts. The applicant for admission is required to demonstrate adequate undergraduate preparation, and may under certain circumstances be asked to submit Graduate Record Examination results.

Master of Arts

The master arts in government is a thirty-credit-hour program that can be accomplished in twelve months by full-time students. A comprehensive examination is required. The student may take twenty-four hours of course work and six hours of thesis or may take all thirty credit hours in course work. A graduate-level course in research methods is required of all candidates for the master of arts degree.

The master of arts program is intended for the student with liberal arts or natural science preparation who has a professional interest in government. The master of arts may be a preparatory step toward doctoral work at another institution or a final degree preparatory for teaching in junior and community colleges or research positions in governmental, institutional or industrial settings.

Master of Public Administration

The master of public administration is a final degree emphasizing career preparation for governmental service. The program is designed to emphasize administration in all levels of governmental service—national, state, urban and municipal—and non-governmental service in quasi-public and academic organizations.

The program consists of four parts:

core curriculum (twelve credit hours).
The core curriculum consists of courses in public management, legal foundations of public administration, governmental budgeting, and public policy.

methodology and tools (six credit hours).
Two methodology courses, one dealing with basic methodological issues and techniques and another with field applications and data analysis, are required. Govt 421 and Govt 463 are designed to fulfill these requirements, but other courses may be substituted with the approval of the adviser. Also, a basic proficiency in accounting is required.

public administration electives (nine credit hours).
These electives, chosen in consultation with an adviser, may include courses from a number of departments such as government, economics, history management, and social relations.

internship (three credit hours).
This will be a specially arranged program. If a student has broad practical experience in public service, the internship requirement may be waived at the discretion of the graduate committee. A thesis-level essay is substituted.

The final requirement for the master of public administration is a comprehensive examination.

Doctor of Arts

The doctor of arts program is designed for students holding the bachelor's or master's degree who wish to prepare for a career in college teaching of political science. The major emphasis of the program is on American politics and institutions. Course work is also available across a wide range of other aspects of political science, however. In every respect, the evaluation standards are equal to those of a doctor of philosophy program. Guidelines developed by the Council of Graduate Schools and American Association of State College and Universities have been followed in planning this program.

The doctor of arts program differs from the doctor of philosophy program in five ways: the requirement of a broader distribution of graduate courses in government; a minor area of study of those students who wish to have bidisciplinary preparation for two-year college teaching; a general examination tailored to the doctor of arts; a nontraditional dissertation aimed at enhancing teaching competence; and supervised internships.

The student entering will follow one of three tracks, depending on whether he or she is: beginning graduate work; transferring up to thirty credit hours for a master of arts in political science; or transferring up to thirty credit hours for a master of arts in a cognate field.

As currently structured, it is possible for the student entering with a bachelor of arts to complete the program in three years of full-time study. The full-time student entering with a master of arts, either in political science or in a cognate field, can complete it in two calendar years.

The doctor of arts program consists of four parts: a core concentration; a concentration in political science; a minor in a cognate field; and a dissertation.

the core curriculum (12 credit hours)
teaching government (3)
research methods (3)
teaching internship (3)
community internship (3)

In addition, it is recommended that doctor of arts students take Psych 411, Interpersonal Awareness.

political science concentration (24-51 credits)
The political science core requirements consist of twelve credit hours. Required courses are The American Polity and Theoretical Issues in American Politics. In addition, the student is required to take at least one-graduate seminar from the public administration field (the courses include Public Management, The Budgetary Process, The Legal Foundations of Public Administration and Public Policy Process) and at least one graduate seminar from the area of American government and public law (the courses include American Constitutional Development, Law and Social Policy, and Community Power Structure).

From twelve to thirty-nine additional credits in political science (coursework from other departments may be substituted if approved by the adviser) are required. The total number of credits will depend on the student's previous course work at the graduate level. The student's graduate coursework (including transfer credit) must include at least six credits in political theory and six credits in comparative politics.

The student is expected to register for 400-level courses where appropriate, but may fill out the course work with 300-level courses taken for graduate credit.

Cognate minor (9 credit hours). On the basis of interest and undergraduate education, students are encouraged to select their minor from a wide range of subject areas including both the natural and social sciences.

Students entering Lehigh with a master of arts in a cognate field may be excused from all course work in this area.

Dissertation (9-18 credit hours). The course credit allocated to the dissertation will vary from nine credit hours for the student who transfers with a master of arts in a cognate field, to eighteen credit hours for the student who enters the program with a bachelor of arts degree. Regardless of the credits allocated, the standards for the dissertation are identical.

Examination. Those students entering the doctor of arts program without the master's degree in political science will be required to take a continuing proficiency examination prior to their second year of study.

The general examination is taken prior to the commencement of the student's dissertation. It consists of a major written examination (six hours) on American politics and institutions and a minor written examination (three hours) covering the fields of comparative politics and political theory. An oral examination completes the general examination.

The student is required to defend the completed dissertation before the doctoral committee.

Graduate Courses

403. The American Polity (3)
Integrative overview of the American polity's emphasis on national institutions: presidency, Congress, judiciary, party systems and their interrelations.

405. The Budgetary Process (3)
The public budgetary process: competition among interest groups, policy outcomes, intergovernmental relations, and consequences for policy implementation. Rickards

407. American Constitutional Development (3)
The law of the Constitution as expounded by the Supreme Court of the United States. Nature and origins of judicial review, institutional aspects of separation of powers and federalism, economic regulation in a federal system, and political and civil rights. Detailed consideration of judicial policy-making processes and judicial biography. Whitcomb

411. The Legal Foundations of Public Administration (3)
The authority, procedures, and methods used by executive agencies in the administration of public policy and the general problem of adjusting the administrative process to traditional constitutional and legal principles. Barry

413. Modern Political Philosophy (3)
A study of selected modern political philosophers and their continuing effect on politics and political philosophy. Yates

414. Contemporary Political Philosophy (3)
Selected contemporary political philosophers and their responses to conditions of contemporary political life.

419. Theoretical Issues in American Politics (3)
American contributions to main currents in political philosophy from colonial times to present. Yates

421. Research Methods (3)
Research approaches, design techniques, statistical and non-statistical analysis, and computer applications. Rickards

424. Administrative Theory (3)
Administrative theory and practice in both the public and nonpublic spheres in the United States; model building and field research emphasizing the concepts of public and private administrative systems. Colon

431. Public Management (3)
The study of bureaucracy and problems of public and nonprofit organization and management; executive leadership; personnel management systems and regulatory administration. Colon

432. Public Policy Process (3)
Impacts of power relationships on selected public policy areas such as the military, agriculture, housing, environmental, energy, poverty, health, and taxation. May be repeated for credit. Olson

434. Internship (3)
Internship in private or public agency. May be repeated for credit.

437. Teaching Internship (3)
Supervised practice teaching at the college level. For doctor of arts students.

443. Law and Social Policy (3)
The role of law in the development of social policy. Emphasis on judicial and administrative rather than legislative processes. Substantive areas vary from semester to semester; some of the topics are: judicial administration, administrative regulation, law and social change, and foreign legal systems. May be repeated.

451. Comparative Politics (3)
Theory and concepts in comparative politics. Analysis of applications in studies of Western and non-Western political systems.

461. Community Power Structure (3)
A focus on power relations and decision-making on the community level. Special attention given to theories of community power.

463. Methods of Urban Policy Analysis (3)
Analysis of selected topics in urban or state/local policy. Applied research projects include computer-based statistical analysis. Prerequisite: Govt 421 or consent of the department chairperson. Morgan

471. Seminar in Teaching Government (3)
Theories and techniques of instruction, learning, evaluation, instructional design and innovation in the teaching of government. Prerequisite: doctor of arts candidacy or permission of the department chairperson.

472. Workshop in Teaching Government (3)
Directed experience in teaching and instructional design of lower-division government courses.

481. Special Topics (3)
Individual inquiry into some problem of government. Reading, field work, and other appropriate techniques of investigation. Conferences and reports. May be repeated for credit.

482. Special Topics (3)
Continuation of Govt 481.

Hebrew

Modern Hebrew is taught in the department of Modern Foreign Languages. Biblical Hebrew is associated with the department of Religion Studies. Consult the relevant entry in this section.

History

Professors. C. Leon Tipton, Ph.D., chairman; Joseph A. Dowling, Ph.D., distinguished professor; John H. Ellis, Ph.D.; G. Mark Ellis, Ph.D.; Lawrence H. Leder, Ph.D.; William G. Shade, Ph.D.
Associate Professors. Michael Baylor, Ph.D.; Ian P.H. Duffy, D. Phil' James S. Saeger, Ph.D.; Roger D. Simon, Ph.D.
Assistant Professor. James Reid, Ph.D.
Adjunct Professors. John McV. Haight, Jr., Ph.D.; Curtis Keim, Ph.D.; Winfred Kohls, Ph.D.; Renville Lund, Ph.D.

History is the study of human activities. As such, it encompasses not only events and public policy, but the whole sweep of cultural achievements—religion and philosophy, literature and art, economic and social life. Some of the most influential thinkers and public

people of our time (Toynbee, Kennan, Churchill, Kennedy, among other) have studied contemporary problems by viewing the forces in the past that have shaped our world.

Students take courses in three culture areas, examining major developments in each in terms of cause and effect, the historians' main concern. These courses provide training in research, analysis of historical problems, and formulation of historical judgments, as well as in writing. History majors have the foundation for law school, government service, journalism, teaching, and graduate study.

Honors study in history is by invitation of the department in the student's junior year. The student is required to attain an average of 3.25 in history courses, and must demonstrate a special competence in history. Those interested in honors work are urged to consult the department chairman early in their junior year.

Honors students in history may plan special programs, including more in-depth study of two culture areas rather than three. They enroll for three hours credit of unrostered history as part of their thirty-nine credit hours and complete in that course an honors thesis.

Distribution Requirements

The major totals thirty-nine credit hours.

A history major meets the following distribution requirements:

Hist. 1, 2; maximum of twelve hours in courses below 100; minimum of twelve hours in courses numbered above 200 not including Hist. 201 and 395; Hist. 201 or 395; maximum of eighteen hours of courses from any one group, and minimum of three hours from each group listed below.

group a courses

Hist 7	Machine in America (3)
Hist 8	History of Medicine in America (3)
Hist 9	Survey of American History I (3)
Hist 10	Survey of American History II (3)
Hist 53	Religion and the American Experience (3)
Hist 119	Colonial America (3)
Hist 120	Revolutionary America (3)
Hist 124	Women in American History (3)
Hist 131	The Black Experience in America (3)
Hist 135	United States, 1789-1840 (3)
Hist 136	United States, 1840-1877 (3)
Hist 137	United States, 1877-1920 (3)
Hist 138	United States, 1920 to Present (3)
Hist 207	Seminar in the History of Technology (3)
Hist 310	American Military History (3)
Hist 324	American Social History, 1607-1877 (3)
Hist 326	American Social History Since 1877 (3)
Hist 327	American Intellectual History (3)
Hist 328	American Intellectual History (3)
Hist 329	American Foreign Policy (3)
Hist 330	Modern American Foreign Policy (3)
Hist 333	American Urban History to 1880 (3)
Hist 334	American Urban History, 1880 to the Present (3)
Hist 338	Psychohistory (3)
Hist 339	Topics in American Public Health (3)
Hist 340	Topics in American Medicine (3)
Hist 358	American Constitutional and Legal History (3)

group b courses

Hist 11	Survey of European History I (3)
Hist 12	Survey of European History II (3)
Hist 15	English History (3)
Hist 16	English History (3)
Hist 21	Ancient History (3)
Hist 22	Ancient History (3)
Hist 149	Barbarian West (3)
Hist 150	Medieval Civilization (3)
Hist 154	The Holocaust: History and Meaning (3)
Hist 157	The Renaissance and Reformation (3)
Hist 158	Early Modern Europe (3)
Hist 159	Modern Europe (3)
Hist 160	Modern Europe (3)
Hist 243	English History, 1471-1660 (3)
Hist 244	English History, 1660-1789 (3)
Hist 261	A History of Russia to 1855 (3)
Hist 262	A History of Russia, 1855 to Present (3)
Hist 263	Early Modern Germany, 1618-1848 (3)
Hist 264	Modern Germany, 1848 to Present (3)
Hist 267	The Iberian Peninsula (3)
Hist 337	History of Medical Thought (3)
Hist 349	Topics in Modern British History (3)
Hist 350	English Economic History Since 1700 (3)
Hist 355	European Cultural History I (3)
Hist 356	European Cultural History II (3)
Hist 357	English Constitutional and Legal History to 1783 (3)

group c courses

Hist 4	Chinese Civilization (3)
Hist 5	African Civilization (3)
Hist 49	History of Latin America (3)
Hist 50	History of Latin America (3)
Hist 61	Survey of Middle Eastern History I (3)
Hist 62	Survey of Middle Eastern History II (3)
Hist 171	History of Southern Africa (3)
Hist 172	History of West Africa (3)
Hist 173	Topics in Middle Eastern History (3)
Hist 175	Modern China (3)
Hist 176	Topics in East Asian History (3)
Hist 265	Mexico and the Caribbean (3)
Hist 266	Argentina, Brazil and Chile (3)
Hist 368	Seminar in Latin American History (3)

Hist 51, 300, 371, 372, or provisional courses will be placed in one of the above groups in accordance with their contents and emphases.

History majors are encouraged to enroll in courses in economics, English and American literature, government, international relations, philosophy, psychology, religion studies, and social relations. Students intending to do graduate work should acquire a reading knowledge of at least one foreign language, choosing languages appropriate to their area of concentration.

Minor Programs

A student may establish a minor program in history that covers either a geographical, topical, or chronological interest (American, European, technological and medical, or twentieth century history, to mention a few possibilities). Each student's minor program is prepared in consultation with the chairman of the history department. Advanced placement credit may not be used for the minor program. The minor totals at least fifteen hours and conforms to the following pattern:

*six hours in courses numbered below 100
*maximum of six hours in 100 level courses
*minimum of three hours in courses numbered above 200

Undergraduate Courses in History

1. Course of Civilization (3) fall
Civilizations in the East, West, and Africa from earliest times to 1700. Haight

2. Course of Civilizations (3) spring
Civilizations in the East, West, and Africa from 1700 to the present. Haight

4. Chinese Civilization (3)
Imperial China: Thought, literature, and fine arts related to politics and society. The fate of the traditional heritage in the twentieth century. Lund

5. African Civilizations (3)
Sub-Saharan Africa to present. Anthropological examination of traditional societies, chronology of indigenous African developments. Keim

7. The Machine in America (3)
American technology since colonial times. Changes in techniques and organization of processing, manufacturing, transportation and construction: consideration of social, cultural, and economic impact. Simon

8. History of Medicine in America (3)
Institutional development of the American medical profession. John Ellis

9. Survey of American History I (3) fall
Social, economic, cultural and political institutions through Reconstruction, emphasizing their effects on public policy and culture.

10. Survey of American History II (3) spring
Continuation of History 9, emphasizing the impact of industrialization on public policy, thought and social structure.

11. Survey of European History I (3) fall
Development of Western civilization from decline of the Roman Empire to the 17th century. End of the ancient world, origins and growth of medieval civilization, the Renaissance and Reformation. Baylor

12. Survey of European History II (3) spring
European culture and society from the 17th century to the present. Rise of scientific thought and the state system of the ancien regime, impact of the French and industrial revolutions, Nationalism and liberalism, and two world wars and the end of European supremacy. Baylor

15. English History (3) fall
The history of England to 1688. The origins of representative government, the development of English social institutions, the unification of England, and the Renaissance and Reformation in England. Duffy

16. English History (3) spring
English political and social institutions from 1688 to the present. The evolution of parliamentary government, the rise of modern parties, the industrial revolution, and recent social philosophies. Duffy

21. (Greek 21) Ancient History (3) fall
The development of civilization from paleolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic, and literary development of the ancient world; the origin of political institutions. Phillips

22. (Latin 22) Ancient History (3) spring
Continuation of Greek 21, The Hellenistic Age. Rome from its origin to 395 A.D. Phillips

49. History of Latin America (3) fall
Spanish and Portuguese colonization of America and the struggles for independence, preceded by a brief view of the ancient American civilizations and the Iberian backgrounds. Saeger

50. History of Latin America (3) spring
Continuation of Hist 49. The development of the Latin American nations in the nineteenth and twentieth centuries. Saeger

51. Freshman Seminar (3)
An intensive analysis of a particular period, problem or area of history, emphasizing readings, discussions and reports. The topics and instructor vary each semester. Open by invitation to students with advanced placement credit in history or equivalent background, or upon application to the chairman of the department.

53. (RS 53) Religion and the American Experience (3) fall
The historical development of major religious groups in this country from colonial times to the present. Their place in social and political life, and the impact of the national experience upon them. Emphasis on religious freedom and pluralism, and the church-state relationship. A. Eckardt

61. Survey of Middle Eastern History I (3) fall
Social, economic, cultural, and political history of Islam from Mohammed to the mid-18th century. Reid

62. Survey of Middle Eastern History II (3) spring
Continuation of History 61, emphasizing the formation of Islamic states and political events of the 20th century. Reid

119. Colonial America (3) fall
Founding and growth of colonies in North America through circa 1750. Attention will be paid to motives behind European expansion as well as to developments in the colonies. Leder

120. Revolutionary America (3) spring
American political, economic and cultural development from the mid-eighteenth century through the adoption of the Federal Constitution. Leder

124. Women in America (3)
Roles of Women in American Society from Colonial to present times: attitudes toward women, female sexuality, women's work, and feminism. Shade

131. The Black Experience in America (3)
Black subculture in America from the colonial period to the present, emphasizing the struggle for emancipation and equal rights. Topics include: racialism, slavery, Reconstruction, urbanization, protest movements, and the "Second Reconstruction." Shade

135. United States, 1789-1840 (3)
The American political system from the Constitution through Jacksonianism. Special emphasis upon the first and second party systems and the democratization of American political culture. Shade

136. United States, 1840-1877 (3)
Civil War and Reconstruction, emphasizing the causes of the Civil War, its impact upon American society and politics, and problems of postwar reconstruction. Shade

137. United States, 1877-1920 (3)
Political, economic and social responses to industrial America. The rise of the Populist and Progressive movements, coming of World War I, and postwar developments. John Ellis

138. United States, 1920 to Present (3)
American institutions in the modern era, emphasizing critical changes of the 1920s, the Crash of 1929, the New Deal, World War II, and later political, social and economic events. Dowling

145. (STS 145) Introduction To the History of Science (3)
The history of modern science, primarily physical and biological, with emphasis on the development of major theoretical models since the seventeenth century.

149. The Barbarian West (3) fall
Merger of Greco-Roman, Germanic and Christian institutions and culture in Western Europe to mid-eleventh century. Evolution of the church, feudalism and manorialism, and the foundations of the Carolingian and Holy Roman empires. Tipton

150. Medieval Civilization (3) spring
Formation and development of western culture to about 1400. Rise of universities and towns, legal development and origins of representative government, origins of nation-states, scholasticism and decline of the medieval church. Tipton

154. (RS 154) The Holocaust: History and Meaning (3) spring
The Nazi Holocaust in its historical, political and religious setting. Emphasis upon the moral, cultural and theological issues raised by the Holocaust. A. Eckardt

157. (RS 157). The Renaissance and Reformation (3) fall
Transition from medieval to early modern society: decline of medieval civilization; political, social and cultural changes of the Renaissance; development of Protestantism and impact on European politics and culture. Baylor

158. Early Modern Europe (3) spring
Transformation of European civilization from the 30 Years War to the outbreak of the French Revolution. Origins and development of the European state system; absolutism; commercial expansion and competition for empire; science; the Enlightenment; impact on European culture and politics. Baylor

159. Modern Europe (3) fall
Revolutions and reactions in Western Europe from 1789 to 1870. The rise and spread of liberalism and the origins of socialism. Duffy

160. Modern Europe (3) spring
Contemporary Europe; the origins and consequences of two world wars; the rise of revolutionary governments in Italy, Germany and Russia. Duffy

171. History of Southern Africa (3)
Africa south of the Zambesi especially after arrival of Europeans. Portuguese contact with the Bakongo, effect of missionaries, conflicts between British and Boers, exploitation of minerals, apartheid, American policy, and socialism in Angola and Mozambique. Keim

172. History of West Africa (3)
Crop and animal domestication, rise and fall of western Sudan and forest empires, slavery and slave trade, the Fulani jihads, legitimate trade, colonialism, nationalism, and uncertainty since independence. Keim

173. Topics in Middle Eastern History (3)
Problems in major societies of the contemporary Middle East. Reid

175. Modern China (3)
Transformation in nineteenth and twentieth centuries. Effect of Western forces, disintegration of traditional Confucian state and society, emergence of modern nationalism, twentieth-century revolutions and rise of the People's republic. Lund

176. Topics in East Asian History (3)
Topics in major societies of East Asia. Lund

For Advanced Undergraduates And Graduate Students

201. Historical Perspectives (3) spring
Methodologies and interpretations of Western historians from ancient times to the present. G. Mark Ellis

207. Seminar in the History of Technology (3)
Readings and research in the history of technology, the engineering profession, and engineering education in America. Students will pursue topics of individual interest around some general theme. Prerequisite: History 7 or consent of department chairman. Simon

243. English History, 1471-1660 (3) fall
England under the Tudor monarchy and the problems facing its successors culminating in the civil wars and Interregnum. Political, economic, intellectual and religious developments of the period. G. Mark Ellis

244. English History 1660-1789 (3) spring
Constitutional monarchy from the Stuart Restoration to the French Revolution. English civilization in an age of oligarchy, especially the political, social, economic and intellectual sectors. G. Mark Ellis

261. A History of Russia to 1855 (3) fall
Major cultural, social, and political traditions of the Russian people. Kohls

262. A History of Russia, 1855 to Present (3) spring
The Great Reforms, collapse of Tsarist absolutism, revolution of 1917, and formulation and consolidation of the Soviet dictatorship. Kohls

263. Early Modern Germany, 1618-1848 (3) fall
Germany from the 30 Years War to the Revolution of 1848. Origins and development of absolutism, transformation of German society and thought, Austro-Prussian dualism, impact of the French Revolution and defeat of early liberalism. Baylor

264. Modern Germany, 1848 to Present (3) spring
German nationalism and Prussian unification, socio-economic and cultural change in the Second Empire, First World War and the Weimar Republic, origins and growth of fascism, the Third Reich and post-totalitarian Germany. Baylor

265. Mexico and the Caribbean (3)
Emphasis on Mexico and Cuba from the era of Bourbon reforms through the wars of independence to the twentieth century revolutions. Saeger

266. Argentina, Brazil and Chile (3)
Eighteenth-century Spanish imperial readjustments, independence, the emergence of new societies, twentieth-century extremist movements, and the problems of developing nations. Prerequisite: consent of the department chairman. Saeger

267. The Iberian Peninsula (3)
Rise and fall of Spain and Portugal as European and colonial great powers in the early modern period; their development after the Industrial Revolution; emphasis on Spanish Civil War (1936-39). Saeger

300. Apprentice Teaching (3)
See the introduction to this section for an explanation.

310. American Military History (3) spring
The American military tradition from colonial times to the present. America's wars and the development and operation of military institutions within the political, economic, ideological, and technological milieu of American society. Saeger

325. (SR 325) American Social History, 1607-1877 (3) fall
Social change from early agrarian communities to beginnings of industrialism, emphasizing socio-economic class, family structure, and treatment of women and minority groups. Shade

326. (SR 326) American Social History Since 1877 (3) spring
Changing role of women, minorities, and the family during the industrial era. Development of the modern class structure and the impact of the welfare state. Simon

327. American Intellectual History (3) fall
Development of political, social and religious ideas in America from the colonial period to the Civil War. Dowling

328. American Intellectual History (3) spring
Economic, political and religious thought in industrial America, 1860 to present. Dowling

329. American Foreign Policy (3)
Late eighteeth-century origins of American diplomatic ideas, their development and application through the nineteenth century. Leder

330. Modern Foreign Policy (3)
The United States in world affairs from the late nineteenth century to the present; the testing and revision of traditional ideas in the face of changing needs and responsibilities. Saeger

333. American Urban History to 1885 (3) fall
Planning and design of colonial and frontier cities. Impact of transportation innovations and industrialization, emergence of a national system of cities. Internal problems of early industrial cities: housing, transportation, public health, crime, social mobility. Simon

334. American Urban History, 1880 to Present (3) spring
Physical expansion of the industrial city and its relationship to current urban problems. Suburbanization, development of the central business district, reforms in housing and public health, rise of ghettoes, emergence of the city planning profession and the idea of "new towns," impact of the New Deal and "urban renewal." Simon

337. History of Medical Thought (3)
From prehistory to present: shamanism and healing, Greco-Roman medicine, Paracelsus and Harvey, and the germ theory of disease. John Ellis

338. Psychohistory (3) spring
Uses of psychology in history and biography; exploration of problems of methodology, verification of evidence, conceptual frameworks and theories of personality; potentialities and limitations of psychological investigation as an historical technique. Dowling

339. Topics in American Public Health (3)
Readings and research on topics in the history of the American public health movement. Prerequisite: History 8. J.H. Ellis

340. Topics in American Medicine (3)
Readings and research on topics in the history of American medicine. Prerequisite: History 8. J.H. Ellis

349. Topics in Modern British History (3)
Selected topics since 1789, including the class system, the transition from aristocracy to democracy, the welfare state, imperialism, the Irish question, modern political parties, and loss of great-power status. Duffy

350. English Economic History Since 1700 (3)
Emphasizes the industrial revolution, mid-Victorian prosperity, the Great Depression, and the impact of two world wars. Duffy

355. (RS 355), European Cultural History I (3) fall
Major developments in European culture from the late Middle Ages through the 17th century. Late scholasticism, humanism and the Renaissance, varieties of Protestantism, origins of modern science. Baylor

356. European Cultural History II (3) spring
Transformation of European culture from the 18th century to the present. The Enlightenment, cultural impact of the French and industrial revolutions, romanticism and ideologies of the 19th century, contemporary European thought. Baylor

357. English Constitutional and Legal History to 1783 (3) spring
Origins and development of government, administration and law from Anglo-Saxon times to 1783, emphasizing common-law institutions, practices and procedures. Duffy

358. American Constitutional and Legal History (3) fall
Adoption of the federal constitution and its modification and expansion: Anglo-American legal tradition and its transformation. Leder

368. Seminar in Latin American History (3)
Readings and individual investigation of selected topics. Saeger

371. Special Topics in History (1-3)
Intensive study in an area of history not adequately covered in currently listed offerings. The course may be administered as a reading program or otherwise as may seem best to meet the needs of students of unusual ability and adequate preparation. Prerequisite: Consent of the department chairman.

372. Special Topics in History (1-3)
Continuation of History 371. Prerequisite: Consent of the department chairperson.

395. Quantitative Methods in Historical Studies (3)
Historical uses and methods of quantitative analysis, including the application of descriptive statistics, statistical inference, and computer technology to a variety of problems drawn from European, American and Latin American history. Shade

For Graduate Students

Linderman Library is especially rich in materials for advanced study and research in history, and the department of history offers program leading to master of arts and doctor of philosophy degrees. Graduate programs provide intensive and specialized study, and the policy of limited enrollment permits close relations between faculty and students.

Admission to graduate study in history is competitive and dependent upon the applicant's undergraduate preparation and record, recommendations, and Graduate Record Examination scores. Besides general requirements for the Graduate School, the following special requirements apply to graduate study in history.

Master of Arts

There are two masters programs. Under plan I, a candidate may earn the degree by successfully completing twenty-four hours of approved course work and submitting a satisfactory thesis. Those continuing toward a doctorate elect plan I. Candidates declaring plan II do not write a thesis, but take thirty hours of course work in and pass examinations in two fields chosen from American, British, European and Latin American history. Candidates in either plan are required to maintain a 3.0 average in all graduate work and to take at least one research seminar.

Doctor of Philosophy

The history department is not currently accepting applicants for the doctor of philosophy degree. The following regulations apply only to those candidates still enrolled.

Candidates for the doctor of philosophy in history must maintain a 3.25 history average and a 3.0 over-all average on all graduate work taken at Lehigh or elsewhere. Students entering with a master's degree take a qualifying examination before beginning their second semester at Lehigh. During the second semester, doctoral students select four history fields and one outside field and prepare themselves for written and oral examinations in those fields. An original dissertation is required and may be written only in a primary field.

Primary fields. Primary fields are Great Britain, Colonial America, nineteenth-Century America, and twentieth-Century America.

Other fields. Other fields of specialization are

Medieval-Renaissance, Modern Europe to 1789, Modern Europe Since 1789, and Latin America.

Language requirements. The qualifying examination in one language must be passed before beginning course work beyond the master's degree in order that the language may be used in doctoral course work. The candidate's special committee, appointed by the chairman of the department, will designate any additional languages for the student, if needed. Languages normally chosen are French, Spanish, Italian, German or Russian. Graduate-level competence in statistical methods and computer application are acceptable as replacement for a foreign language. All graduate majors take Hist 401 and either 404 or 405. All Ph.D. candidates must take 18 hours of directed readings and two research seminars. More detailed regulations are given in the *Handbook for Graduate Work in History,* available in the history department office.

401. Methods in Historical Research (3) fall
Techniques of research in history: training in the critical handling of documentary materials, in measuring the value of evidence, and in formal presentation of the results of research. Required of all graduate students in history. Tipton

404. Historiography: Europe (3)
The approach, methods and interpretations of the leading historians of Europe.

405. Historiography: America (3)
The approach, methods and interpretations of the leading historians of America.

442. Readings in American History (3)
Study in small groups under the guidance of a faculty member of the literature of a particular period, problem, or aspect of American history. May be repeated for credit with permission of the department chairman.

443. Readings in English History (3)
Study in small groups, under the guidance of a faculty member, of the literature of a particular period, problem, or area of English history. May be repeated for credit with permission of the department chairman.

444. Readings in Latin American History (3)
Study in small groups, under the guidance of a faculty member, of the literature of a particular period, problem, or area of Latin American history. May be repeated for credit with permission of the department chairman.

447. Readings in European History (3)
Study in small groups, under the guidance of a faculty member, of the literature of a particular period, problem or aspect of European history. May be repeated for credit with permission of the department chairman.

452. Research in American History (3)
An intensive research seminar on a phase of American history. May be repeated for credit with permission of the department chairman.

453. Research in English History (3)
An intensive research seminar on a phase of English history. May be repeated for credit with permission of the department chairman.

454. Research in Latin American History (3)
An intensive research seminar on a phase of Latin American history. May be repeated for credit with permission of the department chairman.

457. Research in European History (3)
An intensive research seminar on a phase of European history. May be repeated for credit with permission of the department chairman.

Human Development

This is a department of the School of Education. For course listings, see the entry under the School of Education, page 122.

Industrial Engineering

Professors. George E. Kane, M.S., *chairperson;* Arthur F. Gould, M.S.; Mikell P. Groover, Ph.D.; Sutton Monro, B.S.; Wallace J. Richardson, M.S.; Emory W. Zimmers, Jr., Ph.D.
Associate professors. John W. Adams, Ph.D.; Larry E. Long, Ph.D.; Louis J. Plebani, Ph.D.
Assistant professor. George R. Wilson, Ph.D.
Instructors. Andrew N. Kreutzer, M.S.; Weston C. Vogel, B.S.

The curriculum is designed with the principal aim of industrial engineering in view, which is the design, improvement, and installation of integrated systems of people, materials, and equipment for operations by the application of the principles of the mathematical, physical, and behavioral sciences.

Throughout the program there is an integrated series or sequence in the major field that includes not only basic and fundamental courses but specialized courses as well, in the fields of production planning and control, quality control, computer-aided manufacturing, production engineering, information systems, robotics, and operations research. These specialized courses reflect the impact of recent developments in operations research, information processing, and manufacturing systems.

Career Opportunities

There is a growing tendency on the part of industries to select young people from their engineering departments for managerial positions. Because of this the industrial engineering courses are oriented to the principles of scientific management to enable the industrial engineering graduate to accept and succeed in these opportunities.

It is the aim of the industrial engineering program to develop the potential manager for either the manufacturing or service industries as well as the government agency, a graduate well grounded in the fundamentals of science, trained in the principles of engineering analysis and design, and thus prepared to practice the profession of industrial engineering.

Physical Facilities

The manufacturing processes laboratory affords an opportunity to students for gaining understanding and skills in manufacturing processes, experimental design, collection of data, and instrumentation calibration.

The computer-aided manufacturing (CAM) laboratory presents the student with an opportunity to use a mini-computer and microprocessors for data collection, process design, and process control.

The information systems laboratory serves the student by presenting opportunities in interactive programming, data processing, and data base systems.

The microprocessor laboratory serves the student by providing an opportunity to gain understanding and design skill in the application of microprocessors to industrial engineering situations.

An interdisciplinary robotics laboratory provides students with the opportunity to gain first-hand experience with the various types of robots and to gain skill in planning their use.

The work systems laboratory affords the opportunity to

students to analyze and plan human activities at both individual work stations and in the monitoring of multiple machine stations. This is accomplished in part through the use of microprocessor-driven simulators.

Considerable use is made of the university Computing Center facilities in all levels of course work.

Special Programs

Electives within the industrial engineering curriculum. The industrial engineering curriculum offers an extensive program of electives that permits the student to shape a program of study that reflects personal interests. The over-all program of electives is comprised of:

21 credit hours of engineering science electives
15 credit hours of advanced industrial engineering electives
15 credit hours of General Studies electives
9 credit hours of free electives

Use of electives to emphasize an area within industrial engineering. Lehigh's industrial engineering department emphasizes four areas: information systems, manufacturing systems, operations research, and operations management. Students may choose their electives to emphasize one area. Examples of using the elective program for this purpose are as follows:

Information Systems Emphasis

suggested course work

engineering science (21 credit hours)

ECE 83, 315, 317	Electrical Science
Mech 103	Principles of Mechanics
CE 121	Mechanics of Fluids
Met 63	Materials Science
Mech 103	Principles of mechanics

IE electives (15 credit hours)

IE 307	Information Systems Analysis
IE 309	Information Systems Development
IE 310	File Structure and Processing
IE 311	Decision Processes
IE 342	Computer-Aided Manufacturing

General Studies (15 credit hours)

Phil 13	Practical Logic
Journ 21	Creative Writing
Journ 311	Science Writing
Anth 131	Science, Technology and Society
Psych 1	Introduction to Psychology

free electives (9 credit hours)

Speech 31	Business and Professional Speaking
Mgt 270	Organizational Theory *or*
IE 334	Organizational Planning and Control
IE 325	Production Control *or*
Mgt 307	Business Communication Skills

Manufacturing Systems Emphasis

suggested course work

engineering science (21 credit hours)

Mech 1, 11	Mechanics of Solids
Met 63, 213	Materials Science
ECE 81	Electrical Science
CE 121	Mechanics of Fluids
ME 104	Thermodynamics

IE electives (15 credit hours)

IE 332	Product Quality
IE 340	Production Engineering
IE 342	Computer-Aided Manufacturing
IE 343	Microprocessor Systems in IE
IE 344	Metal Machining Analysis

General Studies (15 credit hours)

Anth 131	Science, Technology and Society
Psych 1	Introduction to Psychology
Eco 105	Microeconomic Analysis
Eco 335	Labor Economics
Hist 7	The Machine in America

free electives (9 credit hours)

Speech 31	Business and Professional Speaking
IE 325	Production Control
IE 334	Organizational Planning and Control *or*
Mgt 307	Business Communication Skills

Operations Research Emphasis

suggested course work

Engineering science (21 credit hours)

ECE 81, 317	Electrical Science
CE 121	Mechanics of Fluids
Mech 1, 11	Mechanics of Solids
Met 63	Materials Science
ME 104	Thermodynamics

IE electives (15 credit hours)

IE 311	Decision Processes
IE 315	Advanced Operations Research Techniques
IE 325	Production Control
IE 333	Sampling for Information
IE 336	Analysis of Experimental Data

General Studies (15 credit hours)

Phil 13	Practical Logic
Phil 314	Logical Theory
Anth 131	Science, Technology and Society
Hist 7	The Machine in America
Eco 105	Microeconomic Analysis

free electives (9 credit hours)

Speech 31	Business and Professional Speaking
IE 307	Information Systems Analysis
IE 309	Information Systems Development *or*
Mgt 307	Business Communication Skills

Operations Management Emphasis

suggested course work

engineering science (21 credit hours)

Mech 1, 11	Mechanics of Solids
Met 63, 213	Materials Science
ECE 81	Electrical Science
CE 121	Mechanics of Fluids
ME 104	Thermodynamics

IE electives (15 credit hours)

IE 309	Information Systems Development
IE 311	Decision Processes
IE 325	Production Control
IE 334	Organization Planning and Control
IE 342	Computer-Aided Manufacturing

General Studies (15 credit hours)

Eco 105	Microeconomic Analysis
Eco 229	Money and Banking
Eco 335	Labor Economics
Hist 7	The Machine in America
Psych	Introduction to Psychology

free electives (9 credit hours)

Speech 31	Business and Professional Speaking
Law 201	Business Law
Fin 225	Business Finance *or*
Mgt 307	Business Communication Skills

Options Through Electives

The following section shows how use of electives can help students achieve education goals.

To pursue a technical minor. Students may elect to use their electives to obtain a technical minor. A technical minor requires a minimum of fifteen credit hours. The engineering minors available to industrial engineering majors include molecular biophysics, chemical processing, computers, fluid mechanics and solid mechanics. The courses taken to satisfy the minor are part of the elective program and do not require an academic overload.

To pursue a nontechnical minor. Students may choose to pursue nontechnical minors ranging from classics to economics. A nontechnical minor requires a minimum of fifteen credit hours. The courses taken to satisfy the nontechnical minor are part of the elective program and do not require an academic overload.

Industrial Engineering/Master of Business Administration program. Students in the Industrial Engineering Curriculum may pursue a special IE/MBA program by completing the 42 hours of courses listed below in the suggested sequence while completing their major in one of the BS programs in the college during their first four years. At the end of this period, if they are admitted to the Graduate School, they may be granted their MBA degree upon completion of an additional 39 hours of course work. This can usually be accomplished in two regular semesters and two summer sessions.

All courses listed below under Other Required Courses must have a grade of B- or better in order to be credited toward the MBA program.

The following comprise the required courses during the four years in the college:

required background courses

Eco 1	Economics (4)
Math 21	Analytical Geometry and Calculus I (4)
Math 22	Analytical Geometry and Calculus II (4)
IE 18	Data Processing Fundamentals (3)

other required courses

IE 205	Engineering Statistics (3)
Acct 51	Essentials of Accounting (3) (Free Elective)
Acct 52	Essentials of Accounting (3) (Substituted for Acct 108)
Eco 105	Microeconomic Analysis (3) (General Studies Elective)
Eco 119	Macroeconomic Analysis (3) (General Studies Elective)
Acct 324	Cost Accounting (3) (Free Elective)
IE 206	Operations Research Techniques (3)
Law 201	Business Law (3) (Free Elective)
Eco 229	Money and Banking (3) (General Studies Elective)

Students who do not take Acct 52 and Acct 324 as undergraduates will be required to take Acct 413 as part of their MBA course work.

Major Requirements

freshman year see page 46

sophomore year, first semester (16 credit hours)

Math 23	Analytic Geometry and Calculus III (4)
IE 7	Operations Management and Engineering Economy (4)
Phys 21, 22	Introductory Physics II and Laboratory (3)
	engineering science elective (3)

sophomore year, second semester (16 credit hours)

IE 110	Engineering Probability (3)
IE 18	Information Systems Fundamentals (3)
	engineering science electives (6)
Eco 1	Economics (4)

junior year, first semester (16-19 credit hours)

IE 101	Fundamentals of Manufacturing Engineering (4)
IE 205	Engineering Statistics (3)
Math 205	Linear Methods (3)
	engineering science elective (3)
	General Studies elective (3)
	elective (0-3)*

junior year, second semester (17 credit hours)

IE 104	Work Systems (4)
IE 206	Operations Research Techniques (4)
	engineering science electives (6)
	General Studies elective (3)

summer

IE 100	Industrial Employment

senior year, first semester (15-18 credits)

Acctg 108	Fundamentals of Accounting (3)
IE	Electives (6)
	engineering science elective (3)
	General Studies elective (3)
	elective (0-3)*

senior year, second semester (15-18 credits)

IE 154	Senior Project (3)
IE	electives (9)
	General Studies elective (3)
	elective (0-3)*

For engineering science electives, see the approved list in the industrial engineering office.

*please refer to description of normal program, page 46.

Undergraduate Courses

7. Operations Management and Engineering Economy (4) fall

The study of deterministic models related to production and inventory control as well as basic engineering economy. Laboratory.

18. Information Systems Fundamentals (3) spring

Study of data representation and recording media. The functions of computer input/output devices, storage devices, and the central processing unit. Fundamentals of system analysis and design of computer based information systems. Interactive and batch programming projects using Fortran IV and introductory Cobol. Laboratory. Prerequisite: Engr 1 or equivalent.

100. Industrial Employment (0)

Usually following the junior year, students in the industrial engineering curriculum are required to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Prerequisite: sophomore standing.

101. Fundamentals of Manufacturing Engineering (4) fall

Study of metal processing theory and applications with emphasis on machining and pressworking, automation and numerical control, special processing techniques, workholder design principles. Laboratory.

104. Work Systems (4) spring

Techniques in methods improvement and work measurement. The applications of these techniques to the analysis, design and control of man-machine work systems. Time study, predetermined time systems, work sampling and standard data. Wage incentive plans and

manufacturing control applications. Plant layout project. Laboratory. Prerequisites: IE 101, IE 205.

105. Thesis (3-6)
Candidates for the bachelor degree in industrial engineering may, with the approval of the department faculty, undertake a thesis as a portion of the work in the senior year. Prerequisite: senior standing.

110. Engineering Probability (3) spring
Introduction to the ideas and concepts of elementary probability theory. Intended to provide the background for courses involving statistical analysis of engineering data. Laboratory. Prerequisite: Math 23 previously or concurrently.

154. Senior Project (3) fall-spring
Special study in a problem involving project work in a local industrial plant or service institution. Project work includes consideration of the behavioral sciences. Laboratory. Prerequisite: senior standing in industrial engineering.

168. Production Analysis (3) fall-spring
A course for the engineering student not majoring in industrial engineering. Engineering economy; application of quantitative methods to facilities analysis and planning, operations planning and control, work measurement and scheduling, and operating systems analysis. Prerequisite: Math 22 or 42; Eco 1.

For Advanced Undergraduates and Graduate Students

205. Engineering Statistics (3) fall
Applications of point and confidence interval estimation and hypothesis testing to the fitting of frequency and regression models, to acceptance and control sampling and to elementary design of experiments. Simulation in practice to evaluate unfamiliar statistics. Exposure to a major statistical software package. Prerequisite: IE 110 or Math 231, or equivalent.

206. Operations Research Techniques (4) spring
The development and use of elementary techniques of operations research. Topics include linear programming, queueing theory, probablistic inventory models, simulation and decision analysis. Prerequisite: IE 110 or Math 231.

212. Elementary Design of Experiments (3)
An introduction to the structure of experiments, the analysis of experimental data, and their interrelation. Measurement error, randomization, pairs and blocks, regression, and analysis of variance. Prerequisite: graduate standing or consent of the department chairperson.

300. Apprentice Teaching in IE (1-3)
see the introduction to this section for an explanation.

307. Information Systems Analysis (3) spring
Study of advanced techniques and their application in the analysis and design of information systems. The course emphasis is on the tools and techniques used for structured systems analysis and design. Prerequisite: IE 18 or equivalent.

309. Information Systems Developments (3) fall
Study of information systems development to include design, implementation, evaluation and management. Introduction to data structure concepts, their use in the production of information for an organization and their effects on organizational relationships. Conduct a feasibility study for an information system. Prerequisite: IE 18 or Acctg 111 or equivalent.

310. File Structure and Processing (3) spring
Study of data structures and file organization for effective processing by computer to include storage management and generation, updata, sorting, searching, and query techniques using Cobol. Introduction to data base design and data base management systems. Prerequisite: IE 309 or Acctg 311, or equivalent.

311. Decision Processes (3) spring
Application of the techniques of operations research for decision making. Topics include decisions under certainty, decisions under risk, decisions under uncertainity, value of sampling information, decision trees and game theory. Prerequisite: IE 206 or Mgt 302.

315. Advanced Operations Research Techniques (3) fall
A survey of advanced topics in operations research. Topics include advanced linear programming, dynamic programming, integer programming. Markow chains and network techniques. Prerequisite: IE 206 or consent of department chairperson.

321. Experimental Industrial Engineering (1-3)
Experimental projects in selected fields of industrial engineering, approved by the instructor. A written report is required.

322. Experimental Industrial Engineering (1-3)
Continuation of IE 321.

325. Production Control (3) fall
Quantitative techniques appropriate for the analysis of production and inventory control systems. Topics include forecasting, inventory models, aggregate planning, scheduling and sequencing. Prerequisite: IE 206 or Mgt 302, or equivalent.

332. Product Quality (3)
Inspection for process control and product acceptance. Performance and life tests, increased severity. Evaluation of design in structure, process and performance specifications. Liability, unlikely events. Calibration versus data adjustment, traceability. Quality Assurance organization. Military standards and Federal regulations. Prerequisite: IE 205.

333. Sampling for Information (3)
Sampling strategies to reduce bias, variance, cost and sample size. Efficient estimators. Randomized responses for confidentiality. With applications to business records, consumer opinions, environmental changes. Prerequisite: A course in statistics.

334. Organizational Planning and Control (3) fall
Design of organization and procedures for managing functions of industrial engineering. Analysis and design of resources planning and control, including introduction of change in man-machine systems; manpower management and wage administration. Prerequisite: IE 104 or 168.

336. Analysis of Experimental Data (3)
Analyses of data to discover linear and/or non-linear models that can be used for prediction when theoretical models are unavailable. Use of internal evidence to assess the reliability of models. Prerequisite: IE 205.

340. Production Engineering (3) fall
Develop plans of manufacturing for discrete parts. Product design analysis and engineering materials utilization. Economic analysis of process design alternatives. Introduction to mechanization and automation. Term project. Laboratory. Prerequisite: IE 101.

342. Computer-Aided Manufacturing (3) spring
Analysis and design of manufacturing systems using digital computers. Principal topics: computer-aided techniques, group technology, applications of mini-computers to manufacturing systems. Introduction to adaptive control, numerical control, and optimization strategies for discrete parts manufacturing. Term project. Prerequisites: IE 18, IE 101 or equivalent.

343. Microprocessor Systems in IE (3) fall
Fundamentals of microprocessors and microcomputers for industrial engineering applications. Topics include basic digital concepts, microprocessor programming interfacing, data acquisition and system development for timing, counting, decision making and control. Laboratory. Prerequisite: IE 18 and IE 101 or equivalent.

344. Metal Machining Analysis (3) spring
Intensive study of metal cutting emphasizing temperature and energy relationships and their effect on tool life, power requirements and surface finish. Economic balanacing of metal cutting variables from application of theory. Lectures and laboratory experiments including designing and conducting an original experiment. Prerequisite: IE 101.

Graduate Programs

Programs leading to the master of science and doctor of philosophy degrees are offered by the department in the following fields: manufacturing engineering, information systems, and operations research.

These programs, briefly described, are as follows:

M.S. in Industrial Engineering

The minimum program for the master of science degree consists of twenty-four credit hours of approved course work and completion of a satisfactory thesis.

A master of science program is selected to meet the interests and needs of the student, and courses in other departments for which the student has the prerequisites may be integrated into the major field. Subject to proper approval, nine credit hours of 400-level courses from outside the department may be included among the courses required in the major field. As part of a purposeful major program, collateral courses may be taken in other branches of engineering, mathematics, economics, psychology, and information and computer science.

M.S. in Management Science

The department and the College of Business and Economics administer an interdisciplinary program leading to a master of science degree in management science. Students are admitted and enroll in either department for administrative purposes. The minimum program consists of thirty credit hours of approved coursework.

M. Eng. in Industrial Engineering

This program of study is for those students whose interests are toward design rather than research. This program will provide opportunity to gain breadth of field by required course work in all areas of study within the department. In addition, a design project is carried out under the supervision of the faculty that further emphasizes breadth of field.

Ph.D. in Industrial Engineering

This program is organized to meet the individual goals and interests of industrial engineering students who plan to engage in teaching, consulting, or research activities in industrial, governmental, or educational environments.

Each doctoral student is required to demonstrate competency in several broad fields of industrial engineering related to a personal area of interest and prepare, through formal course work and independent study, for examination in the particular area of specialization by members of the graduate faculty. A dissertation related to the field of specialization is required.

Further information about the doctor of philosophy program is contained in the Graduate School section and in a brochure available from the department.

Areas of Graduate Study

The areas of graduate study and research that are emphasized in the department are as follows:

Operations Research. Emphasis is placed on both the development and applications of operations research techniques. The program is strongly analytical in approach and content. Emphasis is placed on understanding practical problems so that suitable mathematical models can be selected or developed. Such models may be drawn from such areas as inventory theory, queueing theory, simulation, decision theory, dynamic programming, and mathematical programming theory. The operations research student is motivated by a program that emphasizes the mathematical, probabilistic, and computer sciences.

Information systems. The field of information systems embodies management information for decision making and planning, operational systems to control man-machine activity, and methods for system analysis and design. The role of the human is stressed in data gathering, information processing and interaction with system output.

Study and research work relate to performance of computer-based systems, including evaluation criteria and cost effectiveness. Project management, simulation, data management and economic analysis principles and techniques are employed as basic tools in research activities.

The information systems laboratory is available to assist the student whose interest is in this area.

Manufacturing systems. Graduate study in manufacturing engineering involves course work and research opportunities in specific areas related to manufacturing.

The department is currently interested in such areas as metal processing theory, automation and numerical control, computer-aided manufacturing, robotics, manufacturing systems and management, and work systems. Additional related courses are offered in other departments in the College of Engineering and Physical Sciences.

The manufacturing processes laboratory, the microprocessor laboratory, the robotics laboratory, the work systems laboratory, and the computer-aided manufacturing laboratory are coupled with the course work offered in this area of emphasis.

The department offers courses during the late afternoon for the convenience of students who are employed in local industry and are taking graduate work on a part-time basis.

405. Special Topics in Industrial Engineering (3)
An intensive study of some field of industrial engineering.

408. (Acctg 408) Management Information Systems (3)
Philosophies, concepts and methods for systematic planning, development, and implementation of management information systems (MIS). Various methods and approaches to automation of major MIS subsystems. Concepts in computer center organization. Long-range planning for management information systems. Topics related to efficient and effective management of corporate computer centers. Prerequisites: IE 309 or Acctg 311, or equivalent.

410. Design of Experiments (3)
Experimental procedures for sorting out important causal variables, finding optimum conditions, continuously improving processes, and trouble shooting. Applications to laboratory, pilot plant and factory. Prerequisites: Some statistical background and experimentation in prospect.

415. Manufacturing Management (3)
Analysis of the factors entering into the development of manufacturing management philosophy; decision-making process in areas of organization, planning, operation, and control of manufacturing. Influence of the social, technical, and economic environment upon manufacturing management decisions.

416. Dynamic Programming (3)
The principle of optimality; one-dimensional processes, multi-dimensional processes, LaGrange multiplier technique. Markovian decision processes; applications.

417. Advanced Mathematical Programming (3)
Theory and applications of the extensions of linear programming. Kuhn-Tucker conditions, gradient methods of optimization, simplex-based methods of nonlinear programming, integer programming, branch and bound, zero-one discrete programming and stochastic programming. Prerequisite: a course in linear programming.

418. Simulation (3)
Application of discrete and continuous simulation techniques to model industrial systems; random number generation and testing; design of simulation experiments; simulation languages. Prerequisite: knowledge of Fortran and a course in probability theory.

419. Sequencing and Scheduling (3)
A study of sequencing and scheduling problems and models. Specific topics addresses are simple and parallel machine models, flow shop scheduling, analytic and simulation approaches to job shop scheduling, and extensions to resource constrained project scheduling. Prerequisite: IE 315 or consent of department chairperson.

428. Advanced Work Systems (3)
A critical evaluation of methods improvement and work measurement techniques. Emphasis on design of work systems, productivity improvement, and reporting systems to control work. Work sampling, construction of standard data, mathematical models of work systems.

430. (Mgt 430) Management Science Project (3) spring
An analysis of a management problem and design of its solution incorporating management science techniques. An individual written report is required. Recommended to be taken in the last semester of the program.

431. Operations Research Seminar (3)
Extensive study of selected topics in techniques and models of operations research.

433. Manufacturing Engineering Seminar (3)
Extensive study of selected topics in the research and development of manufacturing engineering techniques.

435. Mathematical Methods in Operations Research (3)
The fitting of data using splines and polynomials. The use of differential equations, difference equations. Laplace transforms, generating functions and matrices in the solution of problems arising in scheduling, inventories, maintenance, queueing and replacement. Prerequisites: calculus, linear algebra, knowledge of Fortran or equivalent.

437. Data Base Systems (3)
An intensive treatment of modern data base technology to include logical and physical organization of data bases, control of redundancy, commercially available data base management systems and systems selection methodology. Course includes a design project. Prerequisite: An advanced course in file structures and processing.

438. Design of Communications-Based Information Systems (3)
Concepts and types of communications-based (on-line) information systems. Presentation of the methodology and techniques used for information system development and design as it relates specifically to online systems. Examination of the state-of-the-art of support hardware and software for online systems. Prerequisite: IE 310 or consent of the department chairperson.

439. Applications of Stochastic Processes (3)
Introduction to stochastic processes, application in queueing theory and inventory theory. Prerequisites: a course in probability theory and IE 435.

443. Automation and Production Systems (3)
Concepts and principles of automated production lines; analysis of transfer lines; partial automation; mechanized assembly systems; flexible manufacturing systems; industrial robots; line balancing; product and process design considerations.

444. Design of Cutting Tools (3)
A study of design parameters including tool materials, tool geometry and cutting conditions for material removal operations. Emphasis will be placed on the influence of tool selection variables, on economy of operation and conformance to product requirements.

449. Advanced Computer-Aided Manufacturing (3)
Numerical control in manufacturing; CAD/CAM systems; computer monitoring and control of manufacturing operations; adaptive control and other techniques of process optimization. Manufacturing resource planning, computer-aided process planning, and shop floor control. Prerequisite: IE 342 or consent of the department chairperson.

450. Manufacturing Problems (3)
Discussion and solution of manufacturing problems involving several subfunctions, with emphasis on problem identification and definition; selection of techniques of analysis; procedures for evaluation of proposed solutions.

460. Engineering Project (1-6)
An intensive study of an area of industrial engineering with emphasis upon design and application. A written report is required.

461. Readings (1-3)
Intensive study of some area of industrial engineering which is not covered in general courses.

490. Research Methods Seminar (3)
Research methods in industrial engineering; discussion and criticial analysis of current industrial research; practice in preparation of research proposals.

Instruction and Curriculum

This is a department of the School of Education. For course listings, see the entry under The School of Education, page 122.

International Relations

Professors. Henderson B. Braddick, Ph.D., J.D.; Carey B. Joynt, Ph.D., Monroe J. Rathbone, professor: Zdenek J. Slouka, Ph.D.; Oles M. Smolansky, Ph.D.
Associate professors. Michael R. Hodges, Ph.D.; Raymond F. Wylie, Ph.D.

The program in international relations serves the needs of all types of students. The student concentrating on another field and interested in taking only one or two courses in international relations will find a wide range of selections. Those seeking a more systematic exposure to international relations through a five-course minor program can design their own approach—either to survey the field or to study one of its aspects at a greater depth. For international relations majors, breadth and depth are combined; beyond a solid, common core of courses, the student selects from a range of courses within the international relations field or other disciplines. In this way, an international relations major can study a chosen region in depth (including its languages and culture) or can concentrate on a particular functional field. International relations majors who have demonstrated superior performance in their coursework (an average of 3.5 or above in the major) are eligible for departmental honors, provided that they complete an honors thesis in their senior year.

To serve these diverse needs, the program of international relations employs concepts drawn from history, political science, economics, philosophy, anthropology, sociology, and psychology, and has strong links with classics, religion studies, and literature. The interdisciplinary design not only fits the tradition of a well-integrated liberal arts education; it also sets the program apart from many other undergraduate curricula which are more tightly anchored in only one or two primary disciplines. The department strongly recommends that all majors in international relations have at least a reading knowledge in one or more foreign languages. No international relations major without such competence can be considered for departmental honors.

What does the study of international relations encompass, and what is its aim? Scanning the list of courses provides one part of the answer. The aim is a critical understanding of the vast forces shaping the world and penetrating all human activity—nationalism, the dynamics of war and peace, economic diversity, cultural pluralism, ideological drives, and technological change.

While classroom lectures and seminars, reading, and writing are an inevitable route toward the understanding of international relations, it does not stop there. In addition to a variety of outside experts, diplomats, and statesmen who visit the campus and are accessible to students, there is a "hands-on" dimension: internships can be arranged with federal and other agencies; a study-abroad experience, usually connected with a foreign language program, is available; several student-run conferences at other institutions, including Model UN conferences, are regularly attended by Lehigh students. And almost every year international relations students are selected for Fulbright and other prestigious scholarships abroad. Certainly not all or even a majority of students can or want to participate in these activities; but all of them have the opportunity.

Beyond the fundamentals—intellectual development and civic literacy—where does it all lead?

For those seeking further education or careers in other fields—technical, business, law, or medical—the training in international relations often provides added value in the eyes of employers and graduate schools. Those planning to stay close to international affairs with or without further advanced study have a variety of options: teaching, diplomatic service, other service in federal, state and international agencies, or foreign trade and finance careers.

Recommended Major

required preliminary courses

IR 2	World Politics: Concepts and Principles (3)

and one of the following:

IR 1	World Politics: Evolution of the International System (3)
IR 11	European International Relations 1815-1919 (3)
IR 12	European International Relations since 1919 (3)

required major courses

IR 325	International Political Economy (3)
IR 341	Theories of International Relations(3)
IR 342	The Role of Force in International Relations (3)
IR 353	International Institutions (3)
IR 361	International Law (3)

and twelve semester hours, to be selected (with the approval of the major advisor) from courses in international relations, history, government or economics. At least two courses should concentrate on a specific regional area.

Candidates for departmental honors must attain an average of 3.5 or above in their major courses, demonstrate a reading knowledge of one or more foreign languages, and complete an honors thesis in their senior year.

Minor in International Relations

The minor program is designed for undergraduates of any college who wish to acquire a knowledge of international relations in addition to their major. The program is flexible enough to permit students, in consultation with the minor advisor, to survey the general field of world affairs, or to focus on a specific aspect of it that may relate to their major concentration of study. Students minoring in international relations are required to take five courses (fifteen hours), of which two must be on the senior level.

Undergraduate Courses

1. World Politics: Evolution of the International System (3)
Historical introduction to international politics since 1945. The modern nation-state system; nationalism and imperialism; rise of the super-powers; emergence of the Third World; oudines of a new world order.

2. World Politics: Concepts and Principles (3)
Introductory analysis of major theories of international relations and their application to current problems of world politics. Differing national perceptions on the nature of the international system; the exercise of political, economic and military power in the pursuit of foreign policy objectives; patterns of conflict and cooperation.

10. Model United Nations (1)
Research course leading to the preparation of background materials for Model UN conferences. Hours to be arranged. For pass-fail credit only.

11. European International Relations, 1815-1919 (3)
Politics of the great powers; clashes of interests and international crises; development of alliances and other associations of states; wars and peace settlements; unification of Germany and Italy; influence of nationalism, the industrial revolution, and social ideologies on international relations; World War I and the peace treaties. Braddick

12. European International Relations Since 1919 (3)
Political and strategic structure of Europe in the 1920s; rise of Nazi Germany; politics of international crises, 1935-39; World War II and the new distribution of power in Europe;

development of the cold war; European functional integration; contemporary European international problems; European relations with the United States. Braddick

21. Modern East Asia (3)
International relations of East Asia to 1945, with emphasis on 20th century: Western impact and Eastern response; origins and course of Chinese revolution; rise and fall of Japanese empire; emergence of United States and Soviet Union as Asian powers. Wylie

22. Contemporary East Asia (3)
International politics of East Asia since 1945, with emphasis on recent developments: origins of Cold War in East Asia; rise of China as world power; emergence of Japan as industrial giant; policies of United States and Soviet Union in Asia. Wylie

31. Middle East in World Affairs to 1945 (3)
Political, economic, and social forces behind the rise of modern states in the Middle East; area's role in international politics from Napoleon's invasion of Egypt to the end of World War II. Smolansky

32. Middle East in World Affairs Since 1945 (3)
Rise of Turkish, Iranian, and Arab nationalism; creation of Israel; decline of British and French power; growth of U.S. and Soviet influence; Middle East as the world's major oil producer. Smolansky

41. Science, Technology, and International Relations (3)
Interplay between technological change and the international political system. International implications of large-scale, science-based technologies: ocean exploitation systems, weather modification, environmental alteration, air space and outer-space technologies, disease controls, and agricultural technologies. Slouka

51. American Foreign Policy Since 1945 (3)
Recent and contemporary problems showing how changing international conditions affect the premises, concepts, and objecties of U.S. policy. Joynt

80. Politics of Oil (3)
Rise of large international oil companies since 1920 and their relations with the governments of producing and consuming countries, culminating in the formation of the Organization of Petroleum Exporting Countries (OPEC) and the emergence of the "energy crisis." Hodges

IR 85. Alternative World Futures (3)
Analysis of trends in world politics, global forecasting and alternative futures: global system today; dynamics of change; methods of forecasting; political, economic and social trends; future global scenarios. Wylie

101. Politics of European Integration (3)
Integration process in contemporary West Europe; European communities as examples of peaceful community-building at supranational level. Institutional development of European communities and the political, economic, and social dynamics of regional integration in West Europe. Hodges

133. Diplomacy of Russia to 1945 (3)
Expansion of the Russian Empire; Russian foreign policy under the tsarist and communist governments; interaction between domestic and foreign affairs; Soviet efforts to survive in a "hostile capitalist environment." Smolansky

134. Diplomacy of Russia Since 1945 (3)
Consolidation of gains made during and after World War II; origins of cold war; frictions within the Communist bloc (Eastern Europe and China); nuclear arms race and striving for detente. Smolansky

IR 161. Proseminar in World Politics (3)
Readings on selected themes in world politics, with theme to change each semester. Emphasis on intensive study of texts and development of reading and writing skills through oral and written reports. Prerequisite: Consent of department chairperson. May be repeated for credit. Slouka

Advanced Undergraduate Courses

300. Apprentice Teaching in International Relations (3)

302. War and World Politics (3)
The role of war in the modern world; changing functions of war; why nations go to war; great-power wars, limited wars, civil wars, and intervention; the examples of Hitler's Germany, Japan, Korea, Vietman, and the Arab-Israeli conflict. Prerequisite: IR 1 and 2, or consent of the chairperson. Joynt

303. International Peace Studies (3)
The problem of achieving a peaceful world order; the dynamics of conflict; the role of force, law, and morals. Evaluation of the proposed solutions to violent change. The nuclear era and the challenges to order posed by scarce resources and growing interdependence. Prerequisite: IR 1 and 2, or consent of the department chairperson. Joynt

304. Multinational Corporations As International Actors (3)
Economic, political, and social role of multinational corporations in the international system; emphasis on relations between multinational corporations and national governments. Prerequisite: IR 1 or 2. Hodges

IR 308 (Govt 308) Ideologies in World Affairs (3)
Theories of ideology; nationalism and imperialism; conservatism/liberalism/socialism; Marxism/Leninism/Maoism; fascism/Nazism/militarism; Third World ideologies; the New Left, the New Right, and other recent trends. Wylie

311. World Affairs, 1919-1945 (3)
International relations between the world wars; structure of the state systems in 1919-22; ideals and realities of the League of Nations; challenge of Nazi Germany, Japan, Fascist Italy, and Soviet Russia; appeasement; crises of the 1930s; and World War II. Braddick

312. World Affairs Since 1945 (3)
International relations after World War II; its impact on the state system; cold war and development of bipolar international politics; the United Nations as an instrument for international order and security; decline of the colonial system and emergence of new states; development of Communist China and Western Europe as new power centers; and contemporary problems in international relations. Braddick

318. (Govt 318) Communist Political Systems (3)
Examination of Communist political systems outside the Soviet Union and the operations of nonruling Communist parties.

321. China in World Affairs (3)
Role of China in world affairs, emphasizing triangular relationship involving China, United States, and Soviet Union. Other topics include: Maoist ideology and domestic politics; making of foreign policy; relations with Japan and Europe; policies toward the Third World; current and future problems. Wylie

322. (Govt 322) Politics of Developing Nations (3)
Theories of political development in non-Western areas: modernization and nation building. Field studies and methods; contributions of related disciplines such as sociology and psychology.

IR 325. (Govt 325) International Political Economy (3)
Development of forms of political management of the world economy since World War II, with emphasis on control of interdependence among the industrialized countries, achievement of equity in relations between developed and developing countries, and reintegration of the centrally planned economies into the international economy. Prerequisite: IR 1 and 2, or consent of chairperson. Hodges

IR 331. International Relations of the Middle East (3)
Importance of the region in contemporary world politics; strategic location and natural resources as factors affecting interests of the great powers. Interplay of international, regional and internal forces. Smolansky

334. Soviet Union in World Affairs (3)
Objectives, strategy and tactics of Soviet diplomacy: Russia's status as a superpower. Prerequisite: IR 134 or consent of the department chairperson. Smolansky

IR 335. International Dynamics of Modernization (3)
Impact of modernization on the working of international political system, with emphasis on problems of dependence and dominance. Prerequisite: IR 1 and 2, and consent of chairperson. Slouka

IR 337. Seminar in International Politics of Technology (3)
Research course in selected areas of world politics affected by technological change excluding weapon technologies. Prerequisite: IR 1 or 2, and IR 41 or 335, or consent of chairperson. Slouka

IR 341. Theories of International Relations (3)
Contemporary theories and basic concepts of world politics; application to historic and current issues of international relations. Prerequisite: IR 1 and 2, or consent of the chairperson. Joynt

IR 342. The Role of Force in International Relations (3)
Role of force in international politics: deterrence, limited war, problems of arms control and disarmament; crisis diplomacy. Prerequisite: IR 1 and 2, or consent of the chairperson. Joynt

353. International Institutions (3)
Theory and functioning of the League of Nations and the United Nations; problems of peace and security; regional and functional organizations. Prerequisite: IR 1 and 2, or consent of the chairperson. Braddick

354. Atlantic Community (3)
Political, cultural, and strategic influences affecting relationship between Western Europe, United States, and Canada; the North Atlanttic Treaty Organization; strains in the community, and prospects. Braddick

IR 355. Problems in United States Foreign Policy (3)
Analysis of major issues in defense and security. Prerequisite: IR 51 or consent of chairperson. Joynt

IR 361. International Law (3)
Function of law in international relations, Foundation and structure of international law. Sources of international legal rights and obligations. International law-making and settlement of disputes. Prerequisite: IR 1 and 2, or consent of chairperson. Slouka

IR 362. Seminar in International Law (3)
Case studies in the dynamics of international regulatory processes. Political, socio-economic, and cultural foundations of the international legal system. Prerequisite: IR 361 and consent of chairperson. May be repeated for credit. Slouka

IR 371. Readings in International Relations (3)
Directed course of reading intended for students with special competence or interest in fields of international relations not fully covered by regular course offerings. May be repeated for credit. Prerequisite: consent of chairperson.

372. Reading in International Relations (3)
Continuation of IR 371. May be repeated for credit. Prerequisite: consent of chairperson.

375. Internship in International Relations (1-3)
Internship in public or private agency. May be repeated for credit. Prerequisite: consent of chairperson.

IR 381. Special Topics (3)
Intensive study of some aspects of international politics not covered in another course. Prerequisite: consent of the chairperson.

382. Special Topics (3)
Continuation of IR 381. Prerequisite: consent of the chairperson.

Italian and Italian Studies

See listings under Modern Foreign Languages. There is also a minor in Italian Studies in the College of Arts and Science. Consult the relevant entry in Section III of this catalog.

Journalism

Professor. Robert J. Sullivan, M.A., head
Associate Professor. Sharon M. Friedman, M.A., director of science writing
Assistant Professors. Walter W. Trimble, M.A.; Carole M. Gorney, M.S.J., A.P.R.

The division of journalism offers major and minor programs in print journalism and science writing.

The profession of journalism deals with the truthful communication and explanation of facts. It is the purpose of the program in journalism to bring its majors to a point at which they can gather significant information, organize it quickly and communicate it clearly, accurately and objectively, and to bring them to an understanding of the legitimate role of the press in society.

The first of these objectives is attained by extensive, professionally oriented practice in the reporting, writing and editing of the news. Emphasis is placed on precision and clarity of expression and sophistication of style.

The second objective is attained by study of the rights and responsibilities of the press under the U.S. Constitution and by a senior seminar course, culminating in an undergraduate thesis, in which problems facing the media and the relationship between the media and society are examined.

The basic program in journalism provides an opportunity for the student to pursue a concentration in at least one of the following areas: American studies, economics, government, history, international relations, languages, literature, philosophy, religion studies, various scientific disciplines, social relations and urban studies. Some journalism students elect to pursue a double major. Others choose a minor or a concentration in one of these fields.

A second major program available to journalism students is science writing. Those selecting this major will learn to write, in terms understandable to the general public, about pure and applied scientific research, technology and engineering, medicine and the

environment. A minor in science writing is available for those who wish to major in science or engineering and to become skilled in science communication techniques.

Students interested in environmental writing may wish to pursue a bachelor of science degree in environmental sciences and resource management (ESRM), with a concentration in environmental science writing. This option is offered through the ESRM interdisciplinary program in cooperation with the division of journalism. Students are required to take a core sequence of sixty-six credit hours in science courses and eighteen credit hours in the science writing program. For details, refer to the ESRM program description on page 141.

All science and environmental writing students also may enroll in the science writing field research program, which offers a unique opportunity for practical experience in scientific research and science writing. They also may gain experience by serving on the staff of *Science Scope,* a student-written publication devoted to research at Lehigh.

Although most journalism graduates choose some phase of written communication as a career—newspapers, wire services, magazines, public relations, advertising, technical writing—others have used their background in journalism as a basis for the study and practice of law, graduate study in a variety of disciplines, government service, teaching and business management.

Those concentrating in science writing can expect to pursue careers in science journalism; in public information or public relations for scientific societies, government agencies, universities, industries or hospitals; in technical writing; in other areas, such as management, administration and teaching, in which science communications skills are highly desirable. The program also prepares students for graduate study in science writing, journalism and other disciplines.

Basic Journalism Major

required preliminary courses

Journ 1, 2	Brown and White (2)
Journ 11	News Writing (4)

required major courses

Journ 3-8	Brown and White (2-6)
Journ 17	Magazine Article Writing (3)
Journ 113	Editing (3)
Journ 114	Reporting of Public Affairs (4)
Journ 120	Journalism Proseminar (3)
Journ 122	Law of the Press (3)
Journ 315	Interpretive Writing (3)

Note: *Brown* and *White* must be rostered each semester while the student is a journalism major, and a minimum of four such semesters is required. The course involves work on the student newspaper. With the approval of the journalism faculty, current professional newspaper or other media experience may be substituted semester for semester.

Dual major and recommended electives. Journalism majors are encouraged to declare dual majors in journalism and another field, such as one of those discussed under concentrations above. In-depth knowledge of a specialty area is considered an asset to a journalism career. Those not desiring to declare a dual major should consider either declaring a minor in one of these fields or concentrating their elective courses in one or two of these areas. Dual majors. minors and concentration areas should be chosen in consultation with the major adviser.

Journalism/Science Writing Major

required major courses

Journ 1-8	Brown and White (1-8)
Journ 11	News Writing (4) *or*
Journ 123	Basic Science Writing (3)
Journ 113	Editing (3)
Journ 114	Reporting of Public Affairs (4)
Journ 122	Law of the Press II (3)
Journ 124	Politics of Science (3)
Journ 125	Environment, the Public and the Mass Media (3)
Journ 126	Public Relations (3)
Journ 313	Special Topics in Science Writing (3)

Note: Those concentrating in science writing must roster *Brown and White,* each semester after declaring the major. A minimum of four such semesters is required. Current professional newspaper or magazine experience may be substituted semester by semester.

required science courses. A minimum of twenty-four credits in the physical, biological, environmental or social sciences or engineering is required. These hours can be concentrated in any one area or distributed among all five areas, although an area concentration is recommended. Dual majors in journalism/science writing and a science are encouraged. Science courses should be chosen in consultation with the major adviser.

Science writing field research program. Available to science or environmental writing students at the junior or senior level, this program provides practical experience in scientific research and science writing for students who work on and write about research projects directed by university scientists and engineers.

Another segment of the program allows students to attend major scientific meetings as fully accredited science reporters. Students observe professional science writers in action but write their own stories about the scientific sessions and press conferences held at the meetings.

Journalism Minor

Students who wish to declare a minor program in journalism must be majors in another discipline and take the following:

Journ 1-3	Brown and White (3)
Journ 11	News Writing (4)
Journ 113	Editing (3)
Journ 122	Law of the Press II (3)
Journ 315	Interpretive Writing (3)

Sixteen credits are required.

Science Writing Minor

Students desiring to minor in journalism/science writing must be majors in another discipline, preferably a science. The following courses are required:

Journ 1-2	Brown and White (2)
Journ 11	News Writing (4) *or*
Journ 123	Basic Science Writing (3)
Journ 124	Politics of Science (3)
Journ 125	Environment, the Public and the Mass Media (3)
Journ 126	Public Relations (3)
Journ 312	Advanced Science Writing (3) *or*
Journ 313	Special Topics in Science Writing (3)

Seventeen credits are required.

Journalism Courses

Media Internships
With the approval of the journalism faculty, qualified students may acquire professional experience with area newspapers and magazines or in institutional and agency advertising and public relations. (See Journ 161.)

1-10. Brown and White (1-2) every semester
Enrollment constitutes membership on the staff of the semiweekly undergraduate paper. Students enrolling for their first semester register for Journ 1; for their second semester, Journ 2, etc. Prerequisite: consent of the division head.

11. News Writing (4) every semester
Definition, determinants, and components of news; news story structure and style; sources; interviewing; practice in gathering and writing news. Gorney

17. Magazine Article Writing (3) fall
Writing and marketing nonfiction magazine articles. Gorney

30. Feature Writing (3)
Defining and developing feature stories: human interest, historical, color, personality and news issues; specialized interviewing and writing techniques. Prerequisite: Journ 11 and consent of division head. Trimble

113. Editing (3) fall and spring
Study of and practice in newspaper desk work; headline writing, makeup, and typography; selecting, editing and rewriting news and feature copy; use of reference works and newspaper libraries. Prerequisite: Journ 11. Sullivan, Trimble

114. Reporting of Public Affairs (4) fall
Reporting and writing news of government on the local, county, state and federal levels; civil and criminal courts; labor, environment, housing and community planning news. Prerequisite: Journ 11 and Govt 77. Trimble

118. History of American Journalism (3)
English background of the American newspaper; development of press from colonial days to the present; influence of newspapers on American life; contributions of outstanding journalists. Friedman, Trimble

120. Journalism Proseminar (3) spring
Survey of the press in its relation to public affairs. Extensive research and reports. Prerequisite: consent of the division head. Sullivan

121. Law of the Press (3)
Constitutional development of freedom of the press; rights and responsibilities of the press. Stroup

122. Law of the Press II (3) spring
Law of and defenses in libel; privacy; contempt; copyright; obscenity. Stroup

123. Basic Science Writing (3) fall
Writing news and feature articles on scientific and technological subjects for the mass and specialized media. Prerequisite: six hours of science or consent of the division head. Friedman

124. (STS 124) Politics of Science (3) spring
Organization of the U.S. scientific community and how it interacts with government, the mass media and the public. Friedman

125. Environment, the Public and the Mass Media (3) fall
Public perceptions of environmental problems and of roles played by business, government, the mass media and environmental groups. Analysis of techniques of persuasion, with student investigations of regional environmental problems. Friedman

126. Public Relations (3) spring
Persuasion theory and practice in public relations techniques, especially for non-profit and environmental groups. Press releases, public service announcements, newsletters and pamphlets for clients. Prerequisite: Journ 11 or 123 or 311, or consent of division head. Friedman, Gorney

131. Science Writing Practicum (1-3)
On-site experience as accredited science reporter at major scientific meetings, or writing and research in university laboratories as part of Science Writing Field Research Program. May be repeated for a maximum of eight credits. Prerequisites: Journ 11 or Journ 123 or Journ 311, junior standing, and consent of the division head. Friedman

141. Photojournalism (3)
Ethics and history of photojournalism; practice in techniques of distinguished photojournalists, camera use and darkroom. Students must provide own 35 mm. camera. Enrollment limited. Prerequisite: consent of division head. Trimble

161. Internship (1-3) every semester
Professionally supervised work on commercial newspapers, magazines, radio and television stations, or with public and advertising organizations. Some internships involve science writing. May be repeated for a maximum of six credits. Prerequisite: consent of the division head.

211. Problems in Advanced Reporting (3)
Intensive practice in the reporting of complex events. Prerequisite: Journ 114. Trimble

212. Problems in Advanced Reporting (3)
Techniques of investigative reporting. Prerequisite: Journ 114. Trimble

311. Science Writing (3) fall
Study of and practice in writing about science and technology for general print, electronic media and specialized science publications. Includes news and feature articles, report writing and analysis of factors that influence science communication to the public. Emphasis on writing and organizational skills and translation of scientific materials into lay language. Should be taken by upperclass and graduate students instead of Journ 123. Prerequisite: six hours of science or consent of the division head. Friedman

312. Advanced Science Writing (3)
Further practice, on individual basis, in science writing techniques. Prerequisite: Journ 123 or 311. Friedman

313. Special Topics in Science Writing (3)
Interpretive feature writing on controversial or complex scientific and technological topics. Emphasis on in-depth investigations, interviewing, and balanced reporting. Prerequisite: Journ 11, or Journ 123, or Journ 311, or consent of the division head. Friedman

315. Interpretive Writing (3) spring
Editorial interpretation of current events; practice in interpretive reporting and editorial writing. Prerequisite: Journ 11. Sullivan

Languages

See course descriptions under Modern Foreign Languages, listed alphabetically in the following pages.

Latin American Studies

See listings under Modern Foreign Languages; see also Foreign Careers, where an undergraduate may concentrate on Latin America as a geographical concentration.

Law

Courses in law are found in the entry for accounting and law.

Management, Finance and Marketing

Professors. James B. Hobbs, D.B.A., chairperson, Frank L. Magee Professor of Business Administration; Richard W. Barsness, Ph.D., dean of the College of Business and Economics; Carl R. Beidleman, Ph.D., head, division of finance, DuBois Professor of Finance; John W. Bonge, Ph.D.; Eli Schwartz, Ph.D., Macfarlane Professor of Economics.
Associate professors. James A. Greenleaf, Ph.D.; James E. Hansz, Ph.D.; Raymond L. Horton, D.B.A.; Benjamin Litt, Ph.D.; Thomas L. Parkinson, Ph.D.; Bruce M. Smackey, Ph.D.; John E. Stevens, Ph.D.
Assistant professors. Stephen G. Buell, Ph.D.; Hugh G. Daubek, Ph.D.; Edward T. Grasso, Ph.D.; John B. Guerard, Ph.D.; Michael G. Kolchin, D.B.A.; John David Leahigh, Ph.D; Stephen F. Thode, D.B.A.

Programs and Courses in Finance

The finance major offered in the College of Business and Economics requires fifteen credit hours beyond the core listed on page 44. Each finance major selects either the Business Finance or Financial Economics track.

Business Finance

required courses:
Fin 323 Investments (3)
Fin 328 Corporate Financial Policy (3)
plus two of the following:
Fin 324 Security Analysis (3)
Fin 330 Financial Flows and Markets (3)
Fin 331 Bank Management (3)
Fin 333 Multinational Business Finance (3)
Fin 334 Speculative Markets (3)
plus one additional 300-level finance or finance/economics course.

Financial Economics

required courses:
Fin 323 Investments (3)
Fin 328 Corporate Financial Policy (3)
plus two of the following:
Fin/Eco 332 Monetary-Fiscal Policy (3)
Fin/Eco 340 International Finance (3)
Fin/Eco 353 Public Finance: Federal (3)
Fin/Eco 354 Public Finance: State and Local (3)
plus one additional 300-level finance or finance/economics course.

For Advanced Undergraduates and Graduates

225. Business Finance (3) fall-spring
Introductory corporation finance, which stresses a managerial approach to asset management and capital structure. Financial policies regarding the acquisition of funds and their allocation among competing assets within the firm. Prerequisites: Eco 145, Eco 105, Math 41 and 44, Acctg 51.

330. Apprentice Teaching in Finance (1-3) fall-spring

323. Investments (3) spring
The nature of risk and the form of returns to financial assets. Investor objectives, attitudes, and constraints are considered within the risk-return matrix as the basis for investment decisions. Problems of timing, market characteristics, and portfolio management. Prerequisite: Fin 225. Greenleaf

324. Security Analysis (3) fall-spring
Factors influencing the value of financial securities: earnings forecasts and expectations, uncertainty, required returns, supply and demand for securities and funds, and investor attitudes. Implications of market factors, technical approaches, timing, and screening. Prerequisites: Acctg 111 and Fin 323. Not ordinarily open to CBE graduate students. Beidleman, Buell

328. Corporate Financial Policy (3) spring
Advanced corporate finance; capital budgeting, working capital management, leasing, mergers, and financing. Case studies and complex problems. Prerequisite: Fin 225. Not ordinarily open to CBE graduate students. Guerard

330. Financial Flows and Markets (3) fall
Functions and portfolios of financial intermediaries. Sectoral demand and supply of funds, nature and role of interest rates, term structure and forecasting, impact of inflation and regulation on financial intermediaries and markets, and current developments in the financial system. Prerequisites: Eco 229 and Fin 225. Not ordinarily open to CBE graduate students. Leahigh

331. Bank Management (3) spring
Management of bank assets and liabilities within U.S. system's legal and economic constraints. Bank Management Simulator is used to examine relationships between asset, liability, and profitability decisions. Prerequisites: Eco 229 and Fin 225. Not ordinarily open to CBE graduate students. Leahigh

332. (Eco 332) Monetary-Fiscal Policy (3)
Monetary, credit and fiscal policies of governments and central banks, with particular reference to the policies of the U.S. Treasury and the Federal Reserve System. Current problems are emphasized. Prerequisite: Eco 119 or equivalent.

333. Multinational Business Finance (3)
Issues that underlie the investment, financing, and dividend decisions of multinational firms. Current transactions in foreign currencies, direct and portfolio investment and associated risk management when dealing in foreign countries. Prerequisite: Fin 326. Not ordinarily open to CBE graduate students.

334. Speculative Markets (3) spring
Theoretical and empirical analysis of speculation in various markets, particularly options and futures markets. Term project required. Prerequisite: Fin 323. Greenleaf, Guerard

340. (Eco 340) International Finance (3)
Balance of payments, theory of disturbances and adjustment in the international economy, and international monetary policies.

353 (Eco 353) Public Finance: Federal (3)
Governmental expenditures and revenues, the economics of taxation, and government administration.

354. (Eco 354) Public Finance: State and Local (3)
Issues regarding revenues, expenditures, debit and budgeting policy are examined in the light of fiscal principles and economic effects. Current practices in Pennsylvania and contiguous states. Prerequisite: Eco 353.

371. Directed Readings (3)
Readings in various fields of finance designed for the

student with a special interest in some field of finance not covered in scheduled courses. Prerequisite: consent of the department chairperson. May be repeated.

372. Special Topics (1-3)
Special problems and issues in finance for which no regularly scheduled course work exists. When offered as group study, coverage varies according to interests of instructor and students. Prerequisite: consent of department chairperson. May be repeated.

For Graduate Students

411. Financial Management (3) fall
Introduction to financial management, with consideration of advanced topics, including risk with respect to: valuation, capital structure, dividends, capital budgeting, and working capital management. Prerequisites: Acctg 403, Eco 401, and Eco 405.

430. Investments and Portfolio Management (3)
Investment instruments and institutions, historical performance, technical analysis, risk and diversification, portfolio theory. Prerequisite: Fin 411. Greenleaf

431. Advanced Investment and Portfolio Analysis (3)
Theoretical and empirical examination of recent developments in portfolio theory. Prerequisite: Fin 430. Guerard

432. Financial Management of Financial Institutions (3) spring
Asset and liability management of commercial banks, savings and loan associations, life insurance companies, and pension funds. Short*ly* and long*ly* run responses to changes in economic conditions, interest rates, and regulations. Prerequisite: Fin 411. Leahigh

433. (Eco 433) Valuation Seminar (3) fall
Determinants of financial asset values. The role of uncertainty, imprecise forecasts, risk preferences, inflation, and market conditions. Prerequisite: Fin 411. Beidleman, Buell

434. Cases in Financial Management (3) spring
Integration of multiple topics in corporation finance through analysis of complex cases, including: capital budgeting, working capital management, leasing, mergers, and financing. Prerequisite: Fin 411. Guerard

436. International Financial Management (3) spring
Financial management of multinational firms. Consideration of problems arising from diversity of currencies, investment opportunities, risk, and international capital markets. Case studies. Prerequisite: Fin 411. Beidleman

442. (Eco 422) Foreign Trade Management (3) spring, odd-numbered years
Foreign operations, including export channels in foreign markets, export and import financing, foreign investments, and policies of government and international agencies as they affect foreign operations.

444. (Eco 444) Banking and Monetary Policy (3)
The U.S. monetary and banking structure; the supply and demand for funds; and financial markets. Central bank controls; monetary theory and policy. Prerequisite: a course in money and banking.

447. (Eco 447) Capital and Interest Theory (3) alternate years
Present value theory; investment valuation under certainty and risk; term structure of interest rates; the theory of savings, cost of capital, and capital formation. Prerequisite: consent of the department chairperson.

449. (Eco 449) Public Finance (3) spring, even-numbered years
Taxation of income consumption, and capital; principles of government debt management; budgeting and fiscal planning for economic stability and growth.

451. Quantitative Financial Models (3) alternate years
Relationship of quantitative models to financial theory and applications. Capital budgeting, portfolio selection, security evaluation, cash management, inventory policy and credit analysis. Prerequisite: Fin 411. Greenleaf

457. (Eco 457) Monetary Theory (3)
Role of money in the economy from a theoretical and empirical perspective. Influence of money on prices, interest rates, output and employment is analyzed using models of closed and open economies. Prerequisites: Eco/Fin 444 or equivalent.

459. (Eco 459) International Financial Economics (3)
Analysis of the structure and functioning of the international monetary system, international capital markets, Eurocurrency markets, fixed and floating exchange rates, and the role of international monetary institutions in foreign exchange risk management. Hilley

471. Directed Readings (1-3)
Readings in finance not covered in regularly scheduled coursework. Prerequisite: consent of the department chairperson. May be repeated.

472. Special Topics (1-3)
Problems and issues in finance for which no regularly scheduled graduate course work exists. When offered as group study, coverage varies according to interest in finance. Prerequisite: consent of the department chairperson. May be repeated.

Management Program and Courses

Each undergraduate management major will select either the *Specialization* (15 hours) or *Interfunctional* (18 hours) tract shown below:

Specialization (15 hours)

required courses:	
Mgt 302	Quantitative Methods-Conceptual
Mgt. 321	Organizational Behavior Workshop
*Plus at least one of the following:	
Mgt 309	Purchasing and Materials Management
Mgt 311	LUMAC
Mgt 331	Industrial Relations
Mgt 333	Personnel Administration
Up to two of the following:	
Acctg 324	Cost Accounting
Eco 333	Managerial Economics
Eco 335	Labor Economics
Eco 338	Labor Market Institutions
Eco 352	Advanced Statistical Methods
Eco 357	Applied Econometrics for Business and Economics
Fin 328	Corporate Financial Policy
Mkt 317	Marketing in the Industrial Environment
Mkt 319	New Product Planning
IE 309	Information Systems Development
IE 311	Decision Processes
IE 325	Production Control
IE 334	Organizational Planning and Control

*Courses other than Mgt 302 and Mgt 321 will be selected in consultation with the faculty advisor to comprise one of currently five specialization options.

Interfunctional (18 hours)

required courses:

Mgt 302	Quantitative Methods-Conceptual
Mgt 321	Organizational Behavior Workshop
Acctg 324	Cost Accounting
Fin 328	Corporate Financial Policy
Mkt 317, *or*	Marketing in the Industrial Environment, *or*
Mkt 319	New Product Planning

Plus one of the following:

IE 309	Information Systems Development
IE 311	Decision Processes
IE 325	Production Control
IE 334	Organizational Planning and Control

101. (Eco 101) Introduction to Quantitative Methods (3)
Mathematical concepts within a business and economics framework: linear algebra, partial derivatives, constrained optimization, and integral calculus. Meets mathematics prerequisite for entering MBA students. Not available for credit to CBE undergraduates.

For Advanced Undergraduates and Graduate Students

269. Management of Operations in Organizations (3) fall-spring
Design, operation and control of activities necessary to generate goods or services of profit and nonprofit organizations. Basic concepts and quantitative modes used in operations. Eco 145, Math 44. Stevens, Smackey

270. Organization Theory and Behavior (3) fall-spring
Formal organizations as ongoing systems and the behavior of people within them. Models examined: bureaucratic-rationality; behavioral-social; and adaptive-contingency. Kolchin, Litt

300. Apprentice Teaching in Management (1-3) fall-spring

301. Business Management Policies (3) fall-spring
Case study of business problems and the formulation of policies, strategies and tactics to resolve those problems from the viewpoint of general management. Long-range goal attainment, policy formulation, and administrative implementation for specific functional areas and the total firm. Prerequisites: senior standing in the College of Business and Economics, and completion of the college core.

302. Quantitative Models-Conceptual (3) fall-spring
Quantitative methodologies and their use in business, economics and related areas. Classical optimization techniques, mathematical programming, linear programming, decision theory, game theory, simulation and network models. Prerequisites: Eco 105, Acctg 111 and Mgt 269.

306. Entrepreneurship and Business Policy (3) spring
Case study of problems in creating new ventures or managing family-owned businesses. Integrates knowledge acquired in other courses and stresses development of strategic and administrative policies for particular functions and the company as a whole. Prerequisites: senior standing, completion of College of Business and Economics core, and Mgt 311, as well as approval of the department chairperson. Students may not receive credit for both Mgt 306 and Mgt 301. Satisfies the Mgt 301 or Eco 333 core requirement. Bonge

307. Business Communication Skills (3)
Written and spoken communication through letters, memos, reports, and oral presentations. Formal and informal communication networks, and communication processes.

309. Industrial Purchasing and Materials Management (3)
Negotiating, purchasing, receiving, storing, inventory control, value analysis, procurement information systems, and specialized problems in institutional and government procurement. Lectures and cases. Prerequisite: Mgt 269 or equivalent. Kolchin

311. LUMAC Management Assistance Counseling (3) fall-spring
A field studies course primarily for business and economics majors. Students acquire experience in accounting, financial control, marketing and management under faculty supervision by providing management assistance to small businesses in the Lehigh Valley. Students work in small groups on a direct basis with owners. Prerequisites: junior standing in the College of Business and Economics and consent of the department chairperson. Course may be repeated once for credit. Bonge, Stevens

321. Organizational Behavior Workshop (3) fall-spring
Individual behavior, interpersonal transactions, behavioral processes in small work groups, and the entire organization as an ongoing system. Motivational analysis, role-playing, nonverbal interactions, group problem solving and organizational simulations. Prerequisites: Mgt 270 and permission of the department chairperson. Kolchin, Litt

331. Industrial Relations (3) fall
Interdisciplinary consideration of conflict and conflict resolution procedures in the industrial and related settings, emphasizing behavioral aspects of work roles in intergroup relationships, collective bargaining in private and public sectors, grievance machinery terminating in arbitration, mediation, fact-finding and other aspects of public emergency dispute settlement. Prerequisite: Mgt 269 or equivalent. Stevens

333. Personnel Management (3) fall
Analysis and resolution of personnel problems in organizations. Human resource planning, recruitment, selection, orientation, training, appraisal, compensation, and development. Lectures and cases. Prerequisite: Mgt 270. Kolchin

371. Directed Readings (1-3)
Readings in various fields of management designed for the student who has a special interest in some field of management not covered by the regularly scheduled courses. Prerequisite: consent of the department chairperson. May be repeated.

372. Special Topics (1-3)
Special problems and issues in management for which no regularly scheduled coursework exists. When offered as group study, coverage varies according to interests of instructor and students. Prerequisite: consent of the department chairperson. May be repeated.

For Graduate Students

401. Quantitative Methods in Business and Economics (3)
Quantitative methodologies and applications. Classical optimization techniques, mathematical programming, simulation, decision theory, game theory, network models and statistics. Prerequisite: Eco 401. Greenleaf

413. Organizational Behavior (3)
Interpersonal and group behavior in organizations. Issues of organizational work and perception, motivation, learning, communication dynamics, intergroup relations, and leadership. Kolchin, Litt

423. Operations Management (3) spring
The operations function from the perspective of general management. Development of operations-related models, and formulation and implementation of operations policy in the context of the firm's over-all strategy. Prerequisites: Eco 401 and Mgt 401.

429. Managerial Policy and Decision-Making (3) fall-spring
Integration of theory and analytic techniques through intensive investigation of complex organizational, strategic and financial problems in industrial and nonbusiness entities. Case studies. Prerequisite: graduate-level exposure to accounting, economics, finance, management and marketing. An MBA candidate should take the course near the end of the MBA program. Hobbs

430. (IE 430) Management Science Project (3)
As an individual or as a member of a small group, analysis of a management problem and the design of its solution is made incorporating management science techniques. An individual written report is required. Recommended that it be taken in the last semester of the M.S. in management science program.

431. Organizational Design and Change (3) fall
Variables relevant to determining the design of structures and processes of organizations; techniques pertinent to organizational adaptation to changed environments, technologies and social factors. Prerequisite: Mgt 413.

433. Corporate Enterprise: Concepts and Issues (3)
Contemporary social issues relevant to corporate enterprise. Concepts drawn from political science, economics, business history, law and the behavioral sciences are used to analyze the benefits and social costs of corporations. Corporate power, lifestyles, work and leisure, resources and pollution, and the role of government. Litt

435. Organizational Decision Processes (3)
Role of individual responsibility and information handling styles in managerial decision-making processes in formal organizations. Negotiated decision-making, joint problem solving, and values based on decision-making processes. Prerequisite: Mgt 413. Litt

445. (IE 445) Advanced Mathematical Programming (3)
Theory and applications of the extensions of linear programming. Tucker-Kuhn conditions, gradient methods of optimization, simplex-based methods of nonlinear programming, interprogramming, branch and bound, zero-one discrete programming and stochastic programming. Prerequisite: a course in linear programming.

447. Analytical Methods in Management (3) alternate years
Application of management science methods to industrial and commercial problems. Scientific method, decision theory, linear programming, inventory control, regression analysis, forecasting, simulation, and related areas are examined in the context of accounting, finance, marketing, and manufacturing. Prerequisite: Mgt 302.

455. Managerial Communication Skills (3)
Organization, style, and strategy of language to inform, direct, and persuade. Application of writing, reading, speaking, and listening skills to managerial problems. Case studies.

471. Directed Readings (1-3)
Graduate readings in management not covered in regularly scheduled coursework. Prerequisite: consent of the department chairperson. May be repeated.

472. Special Topics (1-3)
Special problems and issues in management for which no regularly scheduled graduate coursework exists. When offered as group study, coverage will vary according to the interests of instructor and students. Prerequisite: consent of the department chairperson. May be repeated.

Marketing

The marketing major in the College of Business and Economics consists of fifteen credit hours being required beyond the core listed on page from the following:

Required courses

Mkt 312	Marketing Research (3)
Mkt 313	Marketing Communications (3)

Elective courses

Three courses (nine credit hours) from the following:

Mkt 315	Consumer Behavior (3)
Mkt 316	Advertising (3)
Mkt 319	New Product Planning (3)
Mkt 320	International Marketing (3)
Mkt 321	Marketing in the Industrial Environment (3)
Mkt 371	Directed Readings (1-3)
Mkt 372	Special Topics (1-3)

Other approved courses may be used as marketing electives depending upon student's career orientation, such as Acctg 324, Eco 339, Fin 326, and Mgt 302.

For Advanced Undergraduates and Graduate Students

211. Contemporary Marketing (3) fall-spring
The course examines contemporary marketing from a managerial perspective. Design of marketing programs within the context of consumer behavior, the social, economic, and cultural environment, market segmentation, demand, and industry structure. Prerequisite: Eco 105.

300. Apprentice Teaching in Marketing (1-3) fall-spring

312. Marketing Research (3) fall-spring
Quantitative and qualitative information in routine and nonrecurring decision-making. Statistical design of marketing studies, model building, analysis of research studies, and the development of marketing information systems. Case problems and presentation of student research projects examine problems in communicating research results. Prerequisites: Eco 145 and Mkt 211. Hansz, Horton, Smackey

313. Marketing Communications (3) fall-spring
Communication-promotion decision processes of organizations. Impact of source, message and media variables on audience response to communication campaigns and the interactions among these variables. Role of personal selling, sales promotion, publicity, and advertising in marketing. Prerequisite: Mkt 211.

315. Consumer Behavior (3) fall
Principal theories of psychology, social psychology, anthropology and economics which contribute to understanding the behavior and motivations of consumers. Consumer needs and wants; learning theory; the perceptual process; decision-making processes; communication; search behavior; market segmentation and product differentiation; and the adoption and diffusion of innovations. Prerequisites: Mkt 211 and Mkt 312. Horton

316. Advertising (3) spring
Analysis of advertising campaigns and the societal implications of advertising are considered from a managerial perspective. Prerequisite: Mkt 313.

319. New Product Planning (3) spring
Organization and management of marketing activities related to the development of new and improved products. The role of marketing research and preproduction testing in the commercialization process. Application of simulation and risk analysis to the screening of research and development projects. Prerequisites: Mkt 211 and Fin 225. Smackey

320. International Marketing (3) spring
Indirect methods for entering and expanding into markets outside of the U.S. including exporting, agents, licensing and joint ventures. A project assessing the overseas market potential and selecting the proper distribution channel is required. Prerequisites: Fin 225 and Mkt 211. Hansz

321. Marketing in the Industrial Environment (3) fall
Strategies and problems in marketing industrial and consumer products and services. Role of a direct sales force and development of consultative sales approach in industrial marketing. Prerequisites: Fin 225 and Mkt 211. Not ordinarily open to CBE graduate students. Smackey

371. Directed Readings (1-3)
Readings in various fields of marketing designed for the student who has a special interest in some field of marketing not covered in regularly scheduled courses. Prerequisite: consent of the department chairperson. May be repeated.

372. Special Topics (1-3)
Special problems and issues in marketing for which no regularly scheduled coursework exists. When offered as group study, coverage will vary according to the interests of the instructor and students. Prerequisite: consent of the department chairperson. May be repeated.

For Graduate Students

411. Marketing and the Multinational Firm (3)
Stages in the development of multinational firms are developed from initial use of marketing intermediaries, through the evolution of overseas production and marketing, to the eventual integration of the multinational firm. Computer simulation. Prerequisites: Fin 411, Mkt 413, and Mgt 401, or equivalent. Hansz

413. Marketing Management (3) fall-spring
Planning and managing marketing activities: market analysis, buyer behavior, market segmentation, marketing research, product policy and strategy, distribution channels policy, advertising, and sales force management. Prerequisite: Eco 405. Parkinson

433. Strategic Marketing (3) spring
Relationship between strategic market planning and corporate strategy. Role of marketing personnel in developing corporate-wide and business unit strategies. Prerequisite: Mkt 413. Hansz, Parkinson

435. Marketing Information and Decision-Making (3) fall
Obtaining relevant marketing information for decision-making is examined from two perspectives: special projects and information systems. Student projects. Prerequisite: Mkt 413. Hansz

437. Advertising Management (3) fall
Analysis of consumer and industrial advertising campaigns from a managerial perspective. Prerequisite: Mkt 413. Daubek

439. Industrial Marketing and Sales Management (3) fall
Marketing and sales problems associated with manufacturers of industrial products: organization and productivity of the sales force, product line policies, pricing strategies, buyer requirements, customer service, and formal proposals. Prerequisites: Fin 411 and Mkt 413. Smackey

441. Technological Innovation in Organizations (3) spring
Analysis of problems associated with developing and marketing new products and processes in technologically oriented enterprises, from inception of idea to planning marketing strategies. Prerequisites: Fin 411 and Mkt 413. Smackey

443. Buyer Behavior and Marketing Management (3) spring
Concepts, methodologies, and current research involving consumer and organizational buying behavior. Prerequisite: Mkt 413. Horton

445. Management of Sales Operations (3) fall
Planning and organizing strategic sales programs; developing the sales force through recruitment, training, and motivation; control of sales programs through performance evaluation of sales personnel; and integrating sales with other marketing activities. Prerequisite: Mkt 413. Daubek

462. Research Methodology (3) spring, odd-numbered years
Criteria which distinguish scientific research from other significant human activities; development of concepts, laws and theories; general principles of research design; measurement theory; and scientific values and ethics. Students are expected to prepare a defensible dissertation proposal during the course. Open only to doctoral students. Horton

463. (similar to HD 463) Advanced Data Analysis (3) spring, even-numbered years
Applications oriented analysis of variance, regression analysis, and multi-variate analysis. SPSS, BMD, and other computer packages are used to analyze empirical data. Prerequisites: Intermediate statistics or permission of department chairperson. Horton

471. Directed Readings (1-3)
Graduate readings in marketing not covered in regularly scheduled courses. When offered as group study, coverage varies according to the interests of the instructor and students. Prerequisite: consent of the chairperson. May be repeated.

472. Special Topics (1-3)
Problems and issues in marketing for which no regularly scheduled graduate coursework exists. When offered as group study, coverage varies according to the interests of the instructor and students. Prerequisite: consent of the department chairperson. May be repeated.

Mathematics

Professors. B.K. Ghosh, Ph.D., *chairman;* Edward F. Assmus, Jr., Ph.D.; Dominic G. B. Edelen, Ph.D.; Samuel L. Gulden, M.A.; Chuan-Chih Hsiung, Ph.D.; Samir A. Khabbaz, Ph.D.; Jerry P. King, Ph.D., dean of The Graduate School; Gregory T. McAllister, Ph.D.; George E. McCluskey, Ph.D.; Murray Schechter, Ph.D.; Andrew K. Snyder, Ph.D.; Gilbert A. Stengle, Ph.D.; Albert Wilansky, Ph.D., University Distinguished Professor of Mathematics.
Associate professors: Donald M. Davis, Ph.D.; Bennett Eisenberg, Ph.D.; Clifford S. Queen, Ph.D.; Viswanatha R.G. Rao, Ph.D.; Gerhard Rayna, Ph.D.

Assistant professors. Bruce A. Dodson, Ph.D.; Carolyn S. Gordon, Ph.D.; Wei-Min Huang, Ph.D.; David H. Johnson, Ph.D.; Aigli H. Papantonopoulou, Ph.D.; Lee J. Stanley, Ph.D.; Susan Szczepanski, Ph.D.; Charles H. Voas, Ph.D.

Mathematics is the universal language of science, and is essential for a clear and complete understanding of virtually all phenomena. Mathematical training prepares a student to express and analyze problems and relationships in a logical manner in a wide variety of disciplines including the physical, engineering, social, biological, and medical sciences, business, and pure mathematics itself.This is a principal reason behind the perpetual need and demand for mathematicians in government and industry.

The department offers two major programs leading to the degrees of bachelor of arts in mathematics and bachelor of science in statistics. It also offers five minor programs for undergraduates.

Calculus sequences

There are three calculus sequences: Math 21, 22, 23; Math 31, 32; and Math 41, 44. The first sequence should be taken by those students who might go into engineering, mathematics or the natural and physical sciences. The first sequence will always be accepted in place of Math 41 and 44, but not vice versa. Math 41, 42, 43 and 44 are designed primarily for students of the biological, management, and social sciences (BMSS); Math 44 should normally be taken in the semester following Math 41, but Math 42 and 43 may be taken at any time. Math 31 and 32 constitute an accelerated calculus sequence that is at least equivalent to the Math 21, 22, 23 sequence. Enrollment in Math 31 and 32 is limited to those students who have demonstrated exceptional ability in pre-university mathematics. A grade of C- or better in Math 32 entitles a student to receive twelve credit hours for eight hours of work in Math 31 and 32.

B.A. in Mathematics

The B.A. program in mathematics emphasizes fundamental principles as well as the mastery of techniques required for the effective use of mathematics. The program has the flexibility and versatility needed to prepare students for careers in government, industry and education. The program provides a solid foundation for those who want to pursue advanced study in any mathematically oriented field.

The program involves a total of 120 credit hours, 42 of which are in required major courses listed below. The remaining 78 credit hours are for college and university requirements (page 36), general electives, and any additional mathematics courses that a student may wish to take.

Required Major Courses (42 credit hours)

Math 21, 22, 23	Analytic Geometry and Calculus I, II, III (12)
Math 205	Linear Methods (3)
Math 219, 220	Principles of Analysis I, II (6)
Math 243	Algebra (3)
Math 244	Linear Algebra (3)
Math 316	Complex Analysis (3)
Math	Electives (12)

Note: Math 21, 22, 23 may be replaced by Math 31, 32. The twelve hours of electives must be approved by the student's major advisor. The electives must include at least two of the following courses: Math 230, 231, 303, 307, 320 and 342. A student must achieve an average of 2.0 or higher in major courses.

B.S. in Statistics

Statistics is concerned with the development and application of techniques for collecting, analyzing and interpreting data in such a way that the reliability of the conclusions can be quantified. Statistical analysis thus forms a fundamental tool in all experimental sciences and is important in understanding chance phenomena. Mathematical principles, especially probability theory, underlie all statistical analyses.

The B.S. program in statistics is interdisciplinary, and is a cooperative effort of faculty members from several departments. A student participating in the program is enrolled in the department of mathematics and is assigned a faculty advisor whose departmental affiliation depends on the student's needs and interests.

The program involves a total of 120 credit hours, which are divided into four parts.

College and University Requirements (36 credit hours)
See page 36

Required Major Courses (42 credit hours)

Math 21, 22, 23	Analytic Geometry and Calculus I, II, III (12)
Math 7	Elements of Statistics (3)
Math 205	Linear Methods (3)
Math 309	Theory of Probability (3)
Math 310	Probability and Its Applications (3)
Math 334	Mathematical Statistics (3)
Math 374	Statistical Project (3)
CIS 11	Introduction to Structured Programming (3)
CIS 12	Programming Techniques (3)
IE 333	Sampling for Information (3)
IE 336	Analysis of Experimental Data (3)

Note: Math 21, 22, 23 may be replaced by Math 31, 32, and Math 7 may be replaced by Math 231 or Eco 145.

Major Electives (12 credit hours)
Four courses chosen from: Math 208, 219, 244, 313, IE 206, 332, Mkt 422.

Professional Electives (30 credit hours)
These are to be selected from at least two fields of applications of statistics and probability, such as biology, psychology, social relations, computer science, engineering, economics, management.

The major and professional electives must be approved by the faculty advisor.

Minor Programs

The department offers five minor programs in different branches of the mathematical sciences. The minors are designed to provide recognition to those students who take a program of study in mathematics or a related area in addition to their major requirements in the engineering, arts and science or business curricula.

Each program requires twelve credit hours of work shown below, and Math 23 or 32. For substitutions, the student should consult the chairman.

Minor in Pure Mathematics
Math 219, 243, 244
Math 220 or 316

Minor in Applied Mathematics
Math 205, 208, 322
Math 230 or 320 or 323

Minor in Probability and Statistics
Math 7 and 309, or Math 42 and 334
Math 231, and Math 310 or 313

Minor in Actuarial Science
Math 205, 230, 231
Math 309 or 334
For information on examinations of actuarial societies, students may consult their minor advisor.

Minor in Astronomy
Phys 21, Astr 2
Astr 211 or 221, and Astr 232 or 242

Undergraduate Courses

0. Precalculus (0)
Review of the elementary mathematics needed to study calculus. No academic credit. Usually offered in the summer.

5. Introduction to Mathematical Thought (3) spring
Meaning, content, and methods of mathematical thought illustrated by topics that may be chosen from number theory, abstract algebra, combinatorics, finite or non-Euclidean geometries, game theory, mathematical logic, set theory, topology.

7. Elements of Statistics (3) fall
Statistical data and frequency distributions; probability, random variables, and sampling distributions; estimation, confidence intervals, and hypothesis testing; regression and correlation; analysis of variance. Illustrations from biological, engineering, physical and social sciences.

21. Analytic Geometry and Calculus I (4) fall-spring
Functions and graphs; limits and continuity; derivative, differential, and applications; Taylor's Theorem and other approximations; indefinite and definite integrals; trigonometric, logarithmic, exponential, and hyperbolic functions.

22. Analytic Geometry and Calculus II (4) fall-spring
Applications of integration; techniques of integration; separable differential equations; curves and vectors in the plane. Prerequisite: Math 21 or Math 31.

23. Analytic Geometry and Calculus III (4) fall-spring
Vectors in space; partial derivatives; Lagrange multipliers; multiple integrals; vector analysis; infinite sequences and series; exact differential equations and second-order differential equations with constant coefficients. Prerequisite: Math 22.

31. Honors Calculus I (4) fall
Functions and graphs; limits and continuity; derivative and differential; indefinite and definite integrals, logarithmic; exponential, trigonometric and hyperbolic functions; integration; vector algebra and calculus. Math 31 may be used in place of Math 21 to satisfy prerequisites. Prerequisite: consent of the department chairman.

32. Honors Calculus II (4) spring
Vector calculus; solid analytic geometry; series; Taylor's Theorem; approximations; partial derivatives; multiple integrals; line and surface integrals; differential equations. Prerequisite: Math 31 or consent of the department chairman.

41. BMSS Calculus I (3) fall-spring
Functions including the exponential, logarithmic, and trigonometric functions; limits; continuity; differentiation with applications to maximum and minimum problems; antidifferentiation.

42. BMSS Probability (3) spring
Sets, functions, counting methods, probability spaces, conditional probability and independence, random variables, continuous probability spaces, some useful probability distributions—binomial, hypergeometric, Poisson, uniform, exponential and normal.

43. BMSS Linear Algebra (3) fall
Matrices, vectors, vector spaces and mathematical systems, special kinds of matrices, elementary matrix transformations, systems of linear equations, convex sets, introduction to linear programming.

44. BMSS Calculus II (3) fall-spring
Indefinite and definite integrals and the fundamental theorem of calculus with applications; numerical integration; elementary differential equations; functions of several variables and partial derivatives with applications to extremal problems. Prerequisite: Math 41 or Math 21 or consent of the department chairman.

61. Logical Methods (3)
Informal survey of set theory and logic. Manipulation of logical formulas. Methods and terminology of mathematics: formal languages, Boolean algebras, order relations, equivalence classes, and induction.

171. Readings (1-3) fall-spring
Study of a topic in mathematics under individual supervision. Intended for students with specific interests in areas not covered in the listed courses. Prerequisite: consent of the department chairman. May be repeated for credit.

For Advanced Undergraduates and Graduate Students

For students who have not taken their elementary mathematics at Lehigh, the prerequisites for certain advanced courses are stated in terms of the number of semester hours of calculus.

205. Linear Methods (3) fall-spring
Linear differential equations and applications; matrices and systems of linear equations; vector spaces; eigenvalues and application to linear systems of differential equations. Prerequisite: Math 23 or Math 32.

208. Complex Variables (3) fall-spring
Functions of a complex variable; calculus of residues; contour integration; applications to conformal mapping and Laplace transforms. Prerequisite: Math 23 or Math 32 or nine semester hours of differential and integral calculus.

219. Principles of Analysis I (3) fall
The real number system; limits; continuous functions; differential and integral calculus.

220. Principles of Analysis II (3) spring
Continuation of Math 219. Absolute and uniform convergence: functions of several variables; line and surface integrals; implicit functions. Prerequisite: Math 219.

230. Numerical Analysis (3) fall
Representation of numbers and rounding error; numerical solution of equations; quadrature; polynomial and spline interpolation; numerical solution of initial and boundary value problems. Prerequisite: Math 205 (previously or concurrently) and knowledge of either FORTRAN or PASCAL.

231. Probability and Statistics (3) fall-spring
Probability and distribution of random variables; populations and random sampling; chi-square, t, and F distributions; estimation and tests of hypotheses; correlation and regression theory of two variables. Prerequisite: Math 23 or Math 32 or Math 44.

243. Algebra (3) fall-spring
Introduction to basic concepts of modern algebra: groups, rings, and fields.

244. Linear Algebra (3) spring
Thorough treatment of the solution of m simultaneous linear equations in n unknowns, including a discussion of the computational complexity of the calculation. Vector spaces, linear dependence, bases, orthogonality, eigenvalues. Applications as time permits. Prerequisite: Math 43 or Math 205 or Math 243.

302. Advanced Calculus and Exterior Differential Forms (3)
Implicit function theorem, exterior differential forms, Stokes' theorem. The Frobenius and Darboux theorems with applications to topics selected from partial differential equations, electromagnetic theory, classical mechanics, differential geometry, and thermodynamics. Prerequisite: Math 205.

303. Mathematical Logic (3)
A course, on a mathematically mature level, designed not only to acquaint the student with logical techniques used in mathematics but also to present symbolic logic as an important adjunct to the study of the foundations of mathematics.

304. Axiomatic Set Theory (3)
A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion theorem; axiom of choice; independence questions. Prerequisite: Math 219 or consent of the department chairman.

307. General Topology I (3) fall
An introductory study of topological spaces, including metric spaces, separation and countability axioms, connectedness, compactness, product spaces, quotient spaces, function spaces. Prerequisite: Math 219.

308. Algebraic Topology (3) spring
Polyhedra, fundamental groups, simplicial and singular homology. Prerequisites: Math 307 and either Math 243 or Math 327.

309. Theory of Probability (3) fall
Probabilities of events on discrete and continuous sample spaces; random variables and probability distributions; expectations; transformations; simplest kind of law of large numbers and central limit theorem. The theory is applied to problems in physical and biological sciences. Prerequisite: Math 23 or Math 32 or Math 44.

310. Probability and Its Application (3)
Continuation of Math 309. Random variables, characteristic functions, limit theorems; stochastic processes, Kolmogorov equations; Markov chains, random walks. Prerequisite: Math 309 or consent of the department chairman.

313. Nonparametric Statistics (3)
Order and rank statistics; tests based on runs, signs, ranks, and order statistics; chi-square and Kolmogorov-Smirnov tests for goodness of fit; the two-sample problem; confidence and tolerance intervals. Prerequisite: Math 231 or Math 309 or both Math 7 and Math 23.

316. Complex Analysis (3) spring
Concept of analytic function from the points of view of the Cauchy-Riemann equations, power series, complex integration, and conformal mapping. Prerequisite: Math 219.

320. Ordinary Differential Equations (3)
The analytical and geometric theory of ordinary differential equations, including such topics as linear systems, systems in the complex plane, oscillation theory, stability theory, geometric theory of nonlinear systems, finite difference methods, general dynamical systems. Prerequisite: Math 205.

322. Methods of Applied Analysis I (3) fall
Fourier series, eigenfunction expansions, Sturm-Liouville problems, Fourier integrals and their application to partial differential equations; special functions. Emphasis is on a wide variety of formal applications rather than logical development. Prerequisite: Math 205 or consent of the department chairman.

323. Methods of Applied Analysis II (3) spring
Green's functions; integral equations; variational methods; asymptotic expansions, method of saddle points; calculus of vector fields, exterior differential calculus. Prerequisite: Math 322.

327. Groups and Rings (3) fall
An intensive study of the concepts of group theory including the Sylow theorems, and of ring theory including unique factorization domains and polynomial rings. Prerequisite: Math 243 or consent of the department chairman.

332. Numerical Analysis (3)
Advanced quadrature methods, multistep methods for ordinary differential equations, and introduction to numerical methods for partial differential equations. Prerequisite: Math 230.

334. Mathematical Statistics (3)
Populations and random sampling; sampling distributions; theory of statistical estimation; criteria and methods of point and interval estimation; theory of testing statistical hypotheses. Prerequisite: Math 231 or Math 309.

342. Number Theory (3)
A survey of elementary and nonelementary algebraic and analytic methods in the theory of numbers. Includes the Euclidean algorithm, Diophantine equations, congruences, quadratic residues, primitive roots, number-theoretic functions as well as one or more of the following topics: distribution of primes, Pell's equation, Fermat's conjecture, partitions. Prerequisite: Math 219 or consent of the department chairman.

344. Linear and Integer Programming (3)
Origin of linear and integer programming problems. Solution of linear programming problems by the simplex algorithm and some of its variants. Duality theory. Solution of integer programming problems by cutting plane and branch and bound methods. Applications to economics, game theory and combinatorial problems. Prerequisite: Math 205.

350. Special Topics (3)
A course covering special topics not sufficiently covered in listed courses. Prerequisite: consent of the department chairman. May be repeated for credit.

371. Readings (3)
The study of a topic in mathematics under appropriate supervision, designed for the individual student who has studied extensively and whose interests lie in areas not covered in the listed courses. Prerequisite: consent of the department chairman. May be repeated for credit.

374. Statistical Project (3)
Supervised field project or independent reading in statistics or probability. Prerequisite: consent of the department chairman.

Graduate Programs in Mathematics

The department offers graduate programs leading to the degrees of master of science in mathematics and the doctor of philosophy in mathematics.

To begin graduate work in mathematics a student must present evidence of adequate undergraduate preparation. The undergraduate program should have included a year of advanced calculus, a semester of linear algebra, and a semester of abstract algebra.

M.S. in Mathematics

The master's program demands thirty semester hours of graduate courses with at least eighteen hours at the

400 level. With the permission of the chairman, up to six hours of these courses can be replaced by a thesis. All students in the master's program must also pass a comprehensive examination.

With a judicious choice of courses a student in the master's program can specialize in pure mathematics, applied mathematics, or statistics. The M.S. degree can serve both as a final degree in mathematics or as an appropriate background for the Ph.D. degree.

Ph.D. in Mathematics

The plan of work toward the doctor of philosophy degree will include a comprehensive examination and a qualifying examination. The latter tests the student's command of some of the following areas: analysis, functional analysis, algebra, combinatorial theory, differential geometry, topology, probability, statistics, logic, numerical analysis, and differential equations. A general examination, a foreign language examination, and the doctoral dissertation and its defense complete the work for the Ph.D. degree.

The department accepts candidates for the Ph.D. who desire to specialize in any of the areas listed above. Each candidate's plan of work must be approved by a special committee of the department. Although there are no specific course requirements, the Ph.D. candidates normally take several courses related to their area of specialization.

For Graduate Students

401. Real Analysis I (3) fall
Lebesgue measure and integration; differentiation; Lp spaces.

402. Real Analysis II (3) spring
Continuation of Math 401. Topics such as general measure and integration theory, Radon-Nikodym theorem, Banach and Hilbert spaces, and Fourier analysis. Prerequisite: Math 401.

404. Mathematical Logic (3)
Topics in quantification theory relevant to formalized theories, recursive functions, Gödel's incompleteness theorem; algorithms and computability.

405. Partial Differential Equations I (3) fall
Classification and transformation of equations; theory of characteristics; initial and boundary value problems; Cauchy's problem for hyperbolic equations; Dirichlet's problem for elliptic equations; potential theory; Green's function; harmonic and subharmonic functions; difference equations; applications to equations of physics. Prerequisite: Math 220.

406. Partial Differential Equations II (3) spring
Continuation of Math 405. Prerequisite: Math 405.

409. Mathematics Seminar (1-6) fall
An intensive study of some field of mathematics not offered in another course. Prerequisite: consent of the department chairman.

410. Mathematics Seminar (1-6) spring
Continuation of the field of study in Math 409 or the intensive study of a different field. Prerequisite: consent of the department chairman.

416. Complex Function Theory (3) fall
Continuation of Math 316. Prerequisite: Math 316 or consent of the department chairman.

419. Linear Operators on Hilbert Space (3)
Algebra and calculus of bounded and unbounded operators on Hilbert space; spectral analysis of self-adjoint, normal, and unitary operators. Interplay between operator theory and classical function theory is emphasized. Prerequisite: Math 220, and Math 208 or Math 316.

423. Differential Geometry I (3) fall
The differential geometry of curves and surfaces in Euclidean space, including problems in the large.

424. Differential Geometry II (3) spring
Multilinear algebra; differentiable manifolds; tensor bundles; exterior differential forms; theorems of Stokes and Frobenius; imbedding theorem; affine connections; holonomy groups; Riemannian manifolds. Prerequisites: Math 423 and Math 308.

425. Differential Geometry III (3)
Continuation of Math 424. Curvature tensor; manifolds of constant curvature; Gauss-Bonnet formula; completeness; harmonic forms; curvature and homology; infinitesimal transformations; conjugate points and Morse index theorem; Lie groups and Lie algebras. Prerequisite: Math 424.

428. Fields and Modules (3) spring
Field theory, including an introduction to Galois theory; the theory of modules, including tensor products and classical algebras. Prerequisite: Math 327.

431. Calculus of Variations (3)
Fundamental existence theorems; necessary conditions and sufficient conditions for relative minima of single integrals; the index theorem; applications to boundary value problems. Prerequisite: Math 401.

435. Functional Analysis I (3) fall
Linear topological spaces; local convexity; function spaces; inductive and weak topologies; duality, separation and extension theorems; the open mapping and uniform boundedness principles: Banach algebras; applications to classical analysis. Prerequisite: Math 307.

436. Functional Analysis II (3) spring
Continuation of Math 435. Prerequisite: Math 435.

443. General Topology II (3)
Continuation of Math 307, with such topics as filters and nets, topological products, local compactness, paracompactness, metrizability, uniformity, function spaces, dimension theory. Prerequisite: Math 307.

444. Algebraic Topology (3)
Continuation of Math 308. Cohomology theory, products, duality. Prerequisite: Math 308.

445. Topics in Algebraic Topology (3)
Selected topics reflecting the interests of the professor and the students. Prerequisite: Math 444.

449. Advanced Topics in Algebra (3)
An intensive study of some topics in algebra with emphasis on recent developments. May be repeated for credit. Prerequisite: consent of the department chairman.

453. Function Theory (3)
The development of one or more topics in function theory, such as analytic continuation, maximum modulus principle, conformal representation, Taylor series analysis, integral functions, Dirichlet series, functions of several complex variables. Prerequisite: Math 416.

455. Algebraic Number Theory I (3)
Ideal theory, Diophantine equations, theory of locally compact fields, p-adic numbers, and cyclotomic fields. Prerequisites: Math 327 and Math 316, or consent of the department chairman.

456. Algebraic Number Theory II (3)
Continuation of Math 455, with emphasis on class field theory and analytic number theory. Prerequisite: Math 455.

461. Mathematical Statistics (3)
An intensive study of one or more topics not sufficiently covered in Math 334, such as theory of statistical tests, statistical estimation, regression, analysis of variance, nonparametric methods, stochastic approximation, decision theory. Prerequisites: Math 334 and Math 401.

463. Probability Theory (3)
An intensive study of one or more topics not sufficiently covered in Math 310, such as limit theorems, Markov processes, ergodic theorems, martingales, time series, stochastic integrals, potential theory. Prerequisite: Math 310 and Math 401.

464. Mathematical Logic (3)
Selected topics not dealt with in Math 404. Prerequisite: Math 404. May be repeated for credit.

471. Homological Algebra (3)
Modules, tensor products, categories and functors; homology functors, projective and injective modules. Prerequisite: Math 428.

472. Finite Groups (3)
An intensive study of the structure of finite groups and their automorphisms. Prerequisite: Math 428.

Mechanical Engineering and Mechanics

Professors. Douglas E. Abbott, Ph.D., *chairperson;* Ferdinand P. Beer, Ph.D., University Distinguished Professor of Mechanical Engineering; Russell E. Benner, Ph.D.; Philip A. Blythe, Ph.D., Center for the Application of Mathematics; Forbes T. Brown, Sc.D.; Fazil Erdogan, Ph.D.; Ronald J. Hartranft, Ph.D.; Stanley H. Johnson, Ph.D.; Arturs Kalnins, Ph.D.; Edward K. Levy, Sc.D, director, Energy Research Center; Alister K. Macpherson, Ph.D.; Jerzy A. Owczarek, Ph.D.; Richard Roberts, Ph.D.; Donald O. Rockwell, Ph.D.; Eric P. Salathe, Ph.D., Center for the Application of Mathematics; Robert G. Sarubbi, Ph.D.; George C.M. Sih, Ph.D., director, Institute for Fracture and Solid Mechanics; Gerald F. Smith, Ph.D., Center for the Application of Mathematics; Dean P. Updike, Ph.D.; Eric Varley, Ph.D., Center for the Application of Mathematics; Robert P. Wei, Ph.D.
Associate professors. Terry J. Delph, Ph.D.; Robert A. Lucas, Ph.D.; Charles R. Smith, Ph.D.; Theodore A. Terry, Ph.D.; J. David A. Walker, Ph.D.; Keisuke Tanaka, Ph.D.
Assistant professors. Osama Badr, Ph.D.; Gary D. Harlow, Ph.D.; Mark S. Lang, Ph.D.; Sudhakar Neti, Ph.D.; John B. Ochs, Ph.D.; Kyra D. Stephanoff, Ph.D.
Visiting professor. Hasan N. Boduroglu, Ph.D.
Adjunct professors. Stanley J. Jakubowski, B.S.M.E., B.S.E.E.; Tulsa Oszoy, Ph.D.; Mustafa R. Ozgu, Ph.D.

Engineering is a creative profession aimed at satisfying needs of society through the combination of material, human and economic resources. Mechanical engineering is one of the broadest of the engineering professions, dealing generally with systems for energy conversion, material transport, and the control of motions and forces.

Mechanical engineers may choose from among many different activities in their careers, according to their interests and the changing needs of society. Some concentrate on the conversion of thermal, nuclear, solar, chemical and electrical energy, or on the problems of air, water, and noise pollution. Some concentrate on the design of mechanical systems used in transportation, production or health care, or by individual consumers. Some will be working, a decade from now, in fields that do not yet exist. Most will be engaged with concepts involving all four dimensions, space and time.

The curriculum leading toward the bachelor of science in mechanical engineering combines a broad base in mathematics, physical sciences, and the engineering sciences (mechanics of solids, materials, dynamics and fluid, thermal and electrical sciences) with exposure to laboratory, the design process, computer-aided analysis and design, and specific applications fields. Much of the latter occurs in five or more courses elected toward the end of the program from a variety of offerings, which are identified by 300-level course designations. Courses in mechanical engineering and mechanics are equally available.

A program also is offered leading toward the bachelor of science in engineering mechanics. This program requires additional courses in mathematics, solid mechanics and dynamics, and less required emphasis on thermodynamics. It is especially appropriate for those most interested in the analysis of the behavior of engineering structures.

Graduates in either degree are equipped for work in engineering or research and development, and in government service or industry. Those with ability and interest have suitable backgrounds for further studies at the graduate level.

Because of the flexibility of the curriculum, candidates for either degree may combine the study of mechanical engineering or engineering mechanics with that of other fields, such as industrial engineering, chemical engineering, materials engineering, and biology, into interdisciplinary programs that will prepare them for further work in the areas of manufacturing, nuclear engineering, energy conversion and conservation, environmental engineering, materials engineering, or biomechanics.

Undergraduates become thoroughly familiar with Lehigh's computer-aided design (CAD) laboratory. The lab is considered a *teaching* facility and the technology is regarded as an engineering tool that can be applied to solving a wide variety of problems. Undergraduates not only use CAD in their coursework but some have developed interactive tutorials that help fellow students expand on and clarify material presented in class.

freshman year (see page 46)

sophomore year, first semester (17 credit hours)

Math 23	Analytical Geometry and Calculus III (4)
Mech 1	Statics (3)
Phys 21, 22	Introductory Physics II and Laboratory (5)
ME 12	Engineering Drawing and Descriptive Geometry (2)
	General Studies requirement (3)

sophomore year, second semester (17 credit hours)

Math 205	Linear Methods (3)
ME 104	Thermodynamics I (3)
Mech 11	Mechanics of Materials (3)
ME 21	ME Laboratory I (1)
Met 63	Engineering Materials (3) *or*
Met 91	Elements of Materials Science
Eco 1	Economics (4)

junior year, first semester (17 credit hours)

Mech 102	Dynamics (3)
ME 105	Thermodynamics II *or* approved elective (3)
ME 231	Fluid Mechanics (3)
ECE 81	Principles of Electrical Engineering (4)
ME 121	ME Laboratory II (1)
	General Studies requirement (2)

junior year, second semester (14-17 credits)

ME 101	Mechanical Engineering Design (1)
ME 151	Mechanical Elements (3)
Mech 203	Advanced Strength of Materials (3)
ECE 162	Electrical Engineering Laboratory (1)
ME 242	Mechanical Vibrations (3)
Math 208	Complex Variables *or*
Math 231	Probability and Statistics (3)
	elective (0-3)*

summer

ME 100	Industrial Employment

senior year, first semester (16 credit hours)

ME 108	Laboratory III (2)
ME 102	Mechanical Engineering Design (2)
	approved electives (6)
	General Studies requirement (3)
	elective (3)

senior year, second semester (14-17 credit hours)

ME 109	Laboratory IV (2)
	approved electives (9)
	General Studies requirement (3)
	elective (0-3)*

*Please refer to description of normal program, page 46.
Note: In the junior year, candidates for the bachelor of science in mechanical engineering take ME 105; candidates for the bachelor of science in engineering mechanics take Math 208.

The approved electives must represent a coherent group of approved courses such as 200- and 300-level courses in mechanical engineering and mechanics, as well as mathematics, physics, chemistry, and a limited number of other fields. For candidates for the bachelor of science in mechanical engineering, six credit hours of approved electives are required in mechanical engineering and at least six more in mechanical engineering or mechanics.

For candidates for the bachelor of science in engineering mechanics, the following courses are required: Mech 302, Advanced Dynamics; Mech 305, Advanced Mechanics of Materials; Mech 307, Mechanics of Continua; and Math 322, Methods of Applied Analysis I.

Undergraduate Courses in Mechanical Engineering

12. Engineering Graphics and Descriptive Geometry (2) fall, spring
Engineering drawing: computer-aided design (CAD), three-dimensional model generation, dimensioning, tolerancing, detail and assembly drawings. Elements of descriptive geometry. Computer graphics.

21. Mechanical Engineering Laboratory I (1) fall, spring
Laboratory methods employed in mechanical engineering and mechanics. Planning and execution of experiments, analysis of data, and writing of reports. Introduction to elementary instrumentation. Prerequisite: Mech 11, previously or concurrently.

100. Industrial Employment (0)
Usually following the junior year, students in the mechanical engineering or engineering mechanics curriculum are expected to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Prerequisite: sophomore standing.

101. Mechanical Engineering Design 1 (1) spring
Objectives and specifications are developed for design projects to be carried out in the following semester. Alternative design concepts are proposed and oral and written reports of feasibility studies are presented.

102. Mechanical Engineering Design II (2) fall
A continuation of ME 101 in which groups are organized to do preliminary design on a previously defined project. Program organization techniques are used and laboratory testing and data acquisition are carried out as needed to promote design development. Prototypes are constructed and tested, when practical. Prerequisites: ME 101, Mech 11, and ME 104.

104. Thermodynamics I (3) fall, spring
Basic concepts and principles of thermodynamics with emphasis on simple compressible substances. First and second law development, energy equations, reversibility, entropy and probability. Properties of pure substances and thermodynamic cycles. Prerequisites: Math 23 and Phys 11.

105. Thermodynamics II (3) fall, spring
Equations of state, nonreacting and reacting mixtures, combustion, equilibrium of mixtures both reacting and nonreacting, statistical thermodynamics concepts. Compressible flow. Prerequisite: ME 104.

108. Mechanical Engineering Laboratory III (2) fall
Lectures and laboratory exercises relating to various phases of engineering laboratory technique and procedures. Includes planning, execution, and analysis of tests and writing of reports. Prerequisite: ME 105.

109. Mechanical Engineering Laboratory IV (2) spring
Continuation of ME 108.

110. Thesis (1-3) fall-spring
Candidates for the degree of bachelor of science in mechanical engineering may, with the approval of the director of the curriculum, undertake a thesis as a portion of the work during the senior year.

121. Mechanical Engineering Laboratory II (1) fall, spring
A continuation of ME 21 including the use of transducers, advanced instrumentation, and data acquisition. Emphasis on the planning of experiments and interpretation of results. Prerequisites: ME 21 and ME 104.

151. Mechanical Elements (3) fall, spring
Methods for the analysis and design of machine elements such as springs, gears, clutches, brakes, and bearings. Motion analysis of cams and selected mechanisms. Projects requiring the design of simple mechanisms of mechanical sub-assemblies. Prerequisites: Mech 11, ME 12 and Mech 102.

166. Procedures for Mechanical Design (2) spring
General design procedures, motion analysis, force analysis, static, repeated and impact types of loading, modes of failure theories. Applications to the design of typical machine elements. Prerequisite: Mech 11.

For Advanced Undergraduates and Graduate Students

231. Fluid Mechanics (3) fall, spring
Fundamental concepts. Physical similarity. Kinematics of fluid flow. Equations of flow in integral form. Equations of flow of perfect fluids. Plane irrotational flow of incompressible fluids. Navier-Stokes equation: hydrodynamic stability; turbulence. Two-dimensional boundary layers in incompressible flows: separation of flow; wakes; drag. Effects of compressibility of fluid flow. Hydraulic treatment of losses in flows in ducts. Flows with free surface. Basic measurements techniques. Prerequisite: Math 205.

242. Mechanical Vibrations (3) fall, spring
Physical modeling of vibrating systems. Linearization. Free and forced single and multiple degree of freedom systems. Simple continuous systems. Engineering applications. Prerequisites: Mech 11, Mech 102 or 103, Math 205.

310. Projects (1-6) fall, spring
Project work on any aspect of engineering, performed either individually or as a member of a team made up of students, possibly from other disciplines. Direction of the projects may be provided by faculty from several departments and could include interaction with outside consultants and local communities and industries. Prerequisite: consent of the department chairperson.

312. Synthesis of Mechanisms (3) spring
Geometry and constrained plane motion with application to linkage design. Type of number synthesis. Comparison of motion analysis by graphical, analytical and computer techniques. Euler-Savary and related curvature techniques as applied to cam, gear and linkage systems. Introduction to the analysis of space mechanisms. Prerequisites: Math 205, Mech 102. Terry

320. Thermodynamics III (3) fall
Advanced treatment of thermodynamic laws both for single element and mixtures. Phase equilibrium. Ideal solutions, chemical equilibrium. Thermodynamic cycle analysis, real fluid properties, availability. Prerequisite: ME 104. Macpherson

321. Introduction to Heat Transfer (3) fall, spring
Analytical, numerical, and analog solutions to steady and transient, one- and two-dimensional conduction problems; thermal radiation, free and forced convection of laminar and turbulent flows inside cylindrical tubes and over external surfaces; thermal design of heat exchangers. Prerequisites: ME 104, ME 231. Levy, Neti

322. Gas Dynamics (3) spring
Equations of flow of compressible fluids. Thermodynamic properties of gases. Shock waves. One-dimensional steady flow through ducts with variable cross-sectional area, flows with viscous friction and heat addition. Prerequisites: ME 231, ME 104, Math 205. Owczarek, Rockwell

324. Aerospace Propulsion Systems (3) spring
Cycle analysis of air-breathing engines. Optimum configurations for different flight regimes. Chemical and nuclear rocket engines. Component design. Prerequisite: ME 105. Badr

325. Vehicular Propulsion Systems (3) fall
Thermal analysis of internal combustion engines for vehicular propulsion. Component design. Unconventional propulsion systems. Applications to current problems in ground transportation. Prerequisite: ME 105. Badr

327. Modern Coal Technology (3) fall
Application of the thermal-fluid sciences in the analysis and critical assessment of coal combustion and conversion processes. Properties of coal; environmental constraints; precombustion cleaning; fluidized bed combustion; flue gas desulfurization; gasification; liquefaction; power cycle analysis; energy economics. Prerequisite: ME 105 or senior standing. Levy

331. Fluid Mechanics (3) fall
Kinematics of fluid flow. Conservation equations for inviscid and viscous flows; integral forms of equations. Two-dimensional potential flow theory of incompressible fluids with applications. Boundary layers. Introduction to free shear layer and boundary layer stability and structure of turbulence. Transition from laminar to turbulent boundary layers. Separation of flow. Steady and unsteady stall. Secondary flows. Flow of non-Newtonian fluids. Hydrodynamic lubrication. Measurement techniques. Prerequisite: ME 231 or equivalent. Owczarek, Rockwell, C. Smith

340. Advanced Mechanical Design (3) spring
Probabilistic design of mechanical components and systems. Reliability functions, hazard models and product life prediction. Theoretical stress-strength-time models. Static and dynamic reliability models. Optimum design of mechanical systems for reliability objectives or constraints. Prerequisite: Math 231. Benner

341. Mechanical Systems (3) fall
Advanced topics in mechanical systems design. Friction, wear and lubrication with applications of friction drives, journal and rolling-element bearings. Shock and vibration control in machine elements such as springs, gears and rotating discs. Rotor-bearing system dynamics. Balancing of rotating and reciprocating machines. Prerequisites: ME 151, Mech 203 and ME 242. Benner

342. Dynamics of Engineering Systems (3) fall
Dynamic analysis of mechanical, electromechanical, fluid and thermal engineering systems with emphasis on the modeling process. Survey of numerical methods with emphasis on dynamic simulation and computer practice. Prerequisite: ME 242. Johnson

343. Control Systems (3) fall, spring
Linear analysis of mechanical, hydraulic, pneumatic, thermal and electrical feedback control systems. Transient and frequency response, root locus, stability criteria and compensation techniques. Prerequisites: Math 205 and ME 242. Brown, Johnson

350. Special Topics (1-4)
A study of some field of mechanical engineering not covered elsewhere. Solar engineering, fluid power and computer-aided design, recently have been offered. Prerequisite: consent of the department chairperson.

360. (ChE 360) Nuclear Reactor Engineering (3) fall, spring
A consideration of the engineering problems in nuclear reactor design and operation. Topics include reactor fuels and materials, thermal aspects, instrumentation and control problems, radiation protection and shielding, fuel processing, and reactor design. Prerequisite: senior standing in engineering of physical science. Clump, Neti

Graduate Programs in Mechanical Engineering

The department offers programs of study leading to the degrees of master of science, master of engineering, and doctor of philosophy in mechanical engineering.

A student whose background is different from that required in the undergraduate mechanical engineering curriculum or who has a particular deficiency may be required to present a larger number of credits than the minimum indicated for graduation.

Subject to approval, courses from other engineering curricula, such as mechanics, chemical engineering, and metallurgy and materials engineering, may be included in the major.

A student who plans to work for the doctorate should submit a general plan to the department chairperson during the first year and arrange for the qualifying examinations.

Master of Science

The M.S. is often considered the appropriate background for the person who wants to work on the more technical creative aspects of mechanical engineering. As such it emphasizes a broad extension of fundamentals rather than specialization in one field, although there is considerable latitude in the choice of courses. The required six-credit-hour thesis for the M.S. likely

concentrates in one research area, but can be viewed primarily as an in-depth project experience under the guidance of an expert.

Master of Engineering

The program leading to the M. Eng. aims primarily at advanced design methods and creative design projects. Six credit hours of ME 460, Engineering Project, are required in lieu of a thesis. A wide range of interdisciplinary course offerings permits construction of a program including several of the following areas: mechanical systems, reliability engineering, probabilistic approaches to design, mechanism synthesis, stress analysis, digital and analog computer-aided design, and optimum design.

Doctor of Philosophy

Candidacy for the Ph.D. follows passage of a qualifying examination that also emphasizes a braod grasp of fundamentals. In most cases, largely through the dissertation, the candidate emphasizes one or more specialized fields and engages in extensive research in collaboration with one or more faculty members. Basic and applied research is ongoing in a variety of fields including fluid and solid mechanics, heat and mass transfer, thermodynamics, energy conversion, mechanical design and system dynamics and control.

Equipment available for research includes mini- and micro-computers with A/D converters, high-speed TV and photographic system, several channels of hot wire/film anemometry, a six-inch interferometer, a two-phase boiling loop, several water and wind tunnels, fluidized bed test facilities, a fluidized combustor, gas-dynamic test facilities, a corrosion fatigue test facility, a variety of electrodynamics and servo-controlled hydraulic testing machines, a 1200-pound shaker table, a photo-elastic bench, lasers, and fluid power test stands. The Computer-Aided Design (CAD) Laboratory includes a DEC VAX 11/780 mini-computer that drives six McAuto Unigraphics stations, six DEC VS11 color dynamic terminals and five VT100 terminals, commercial software is available for design, testing, analysis and solids modeling.

Some of the recent research activities of the staff are listed below.

Thermofluids. Structure of turbulent boundary layers, wakes and jets; drag reduction in turbulent flows; acoustic-flow interactions; attenuation of aerodynamic noise; flows in radial compressors; vortex-solid boundary interactions, flow in gas centrifuges; unsteady viscous flows; viscous effects in turbomachinery; rotating fluidized beds; fluidized bed combustion; instrumentation for liquid film dynamics; inverse annular two-phase flows; laminarturbulent transaction behind a barrier; self-sustained oscillations of separated flows; flow-induced vibrations; fluid transients in tubes; Laser-Doppler velocimetry; fluidized-bed heat exhangers; multi-component boiling; convection in postcritical heat-flux boiling; thermal hydraulics of liquid metal boiling; Raman spectra applied to temperatures in two-phase flow; measurements in gas flows following shock waves; optimization of designs of air separation plants; cycle analysis for fluidized-bed combustors; cycle analysis applied to coal gasifiers and powercycles; breeder-reactor safety; light-water reactor safety; control optimization of heat pumps; finite element computations relative to turbulent flows; flutter of blades in axial-flow turbomachinery.

System dynamics and control. Modeling and advanced simulation of dynamic systems including vehicles, chemical processes, aero-elastic structures and heat-pump systems; methods of experimental identification and analysis of distributed-parameter systems including unsteady turbulent flow in tubes and diffusers; energy methods and bondgraphs in modeling; stochastic optimal control techniques applied to stable platforms for overland vehicles; concepualization and hardware development of innovative components and systems for fluid power control; application of robots to manufacturing; computers controlled theatre lighting design.

411. Boundary-Layer Theory (3)
The course is intended as a first graduate course in viscous flow. An introduction to boundary-layer theory, thermodynamics and heat transfer at the undergraduate level are assumed to have been completed. Topics include the fundamental equation of continuum fluid mechanics, the concept of asymptotic methods and low and high Reynolds number flows, laminar boundary layers, generalized similarity methods, two- and three-dimensional flows, steady and unsteady flows and an introduction to hydrodynamic stability. The material is covered in the context of providing a logical basis as an introduction to a further course in turbulent flows. Abbott

413. Numerical Methods in Mechanical Engineering (3)
Zeros of functions, difference tables, interpolation, integration, differentiation. Divided differences, numerical solution of ordinary differential equations of the boundary and initial value type. Eigen problems. Curve fitting, matrix manipulation and solution of linear algebraic equations. Partial differential equations of the hyperbolic, elliptic and parabolic type. Application to problems in mechanical engineering. Walker

415. Flow-Induced Vibration (3)
Excitation of streamlined- and bluff-bodies by self-flutter, vortex, turbulence, and gust-excitation mechanisms. Analogous excitation of fluid (compressible- and free-surface) systems having rigid boundaries. Extensive case studies. Rockwell

420. Advanced Thermodynamics (3) spring, 1984
Critical review of thermodynamics systems. Criteria for equilibrium. Applications to electromagnetic systems. Statistical thermodynamics. Irreversible thermodynamics. Thermoelectric phenomena. Macpherson

421. Topics of Thermodynamics (3)
Emphasis on theoretical and experimental treatment of combustion processes including dissociation, flame temperature calculations, diffusion flames, stability and propagation; related problems in compressible flow involving one-dimensional, oblique shock waves and detonation waves. Methods of measurement and instrumentation.

424. Turbulent Flow (3) fall, 1983, and spring, 1985
Stability of laminar flow; transition to turbulence. Navier-Stokes equations with turbulence. Bounded turbulent shear flows; free shear flows; statistical description of turbulence. Prerequisite: ME 331. Abbott, Rockwell

426. Radiative and Conductive Heat Transfer (3) fall, 1983, and spring, 1985
Principles of radiative transfer; thermal-radiative properties of diffuse and specular surfaces; radiative exchange between bodies; radiative transport through absorbing, emitting and scattering media. Advanced topics in steady-state and transient conduction; analytical and numerical solutions; problems of combined conductive and radiative heat transfer. Prerequisite: ME 321 or ChE 421.

427. (ChE 427) Multiphase Heat Transfer (3) fall, 1984
Heat transfer and fluid dynamics of multiphase systems. Subcooled, nucleate, and film boiling; bubble nucleation; dynamics of bubble growth and collapse; vapor-liquid

cocurrent flow regimes; two-phase pressure drop and momentum exchange, low instabilities; convective-flow boiling; simultaneous heat and mass transfer. Prerequisite: ME 321 or ChE 421.

428. Boundary Layers and Convective Heat Transfer (3) spring, 1984
Navier-Stokes and energy equations, laminar boundary layer theory, analysis of friction drag, heat transfer and separation. Transition from laminar to turbulent flow. Turbulent boundary layer theory. Prandtl mixing length, turbulent friction drag, and heat transfer. Integral methods. Flow in ducts, wakes and jets. Natural convection heat transfer. Prerequisite: ME 331 or ME 321. Levy, Owczarek, Rockwell

431. Advanced Gas Dynamics (3) spring, 1984
Methods of characteristics. Unsteady continuous flow. Unsteady flows with discontinuities. Shock tubes. Detonation waves. Two-dimensional and axisymmetric supersonic flows. Momentum and energy equation of compressible viscous fluids. Prerequisite: ME 322. Owczarek, Rockwell

432. Topics in Gas Dynamics (3)
The equilibrium thermodynamic properties of a dissociating mixture of gases. Equilibrium flow of dissociating gases. Vibrational and chemical nonequilibrium. Criteria for thermodynamic equilibrium of gas flow. Chemical kinetics of gaseous reactions. Equations of flow of a reacting gas mixture. Nonequilibrium flows. Application to design of ram-jets and rocket nozzles and of reentry vehicles. Prerequisites: ME 320 and ME 322.

439. Fluid Mechanics of Turbo-machinery (3)
The Euler equation. One-dimensional analysis of turbomachinery. Performance characteristics. Limitations on performance imposed by real fluid effects. Cascade flow. Two- and three-dimensional flow. Surge and stall. Owczarek

442. Analytical Methods in Engineering I (3) fall
Analytical methods of solution for discrete and continuous engineering systems. Theoretical, numerical and approximate methods of solution applied to equilibrium, characteristic value and propagation types of engineering problems. Lucas, Walker, Erdogan

443. Analytical Methods in Engineering II (3) spring
Continuation of ME 442.

444. Experimental Stress Analysis in Design (3)
Applications of experimental stress analysis to mechanical design problems. Roberts, Wei

446. Mechanical Reliability (3) fall, 1984
Design of mechanical engineering systems to reliability specifications. Probabilistic failure models for mechanical components. Methods for the analysis and improvement of system reliability. Effect of component tolerance and parameter variation on system failure. Reliability testing. Prerequisite: Math 231 or Math 309. Benner

448. (EE 448) Optimal Control and Design Theory (3) spring, 1984
Parameter optimization in design and optimal open-loop and feedback control via the extrema of unconstrained and constrained functions and functionals (calculus of variations). Matrix and state space formulation. Lagrange multipliers. Pontryagin maximum principle. Hamilton-Jacobi theory, matrix Ricatti equations, sensitivity analysis. Survey of observability and controllability, dynamic programming, and Kalman filter. Intended for engineers with a variety of backgrounds. Prerequisite: ME 340 or 343 or ECE 212 or ChE 286. Brown, Johnson

450. Special Topics (3)
An intensive study of some field of mechanical engineering not covered in more general courses.

451. Seminar (1-3)
Critical discussion of recent advances in mechanical engineering.

458. Modeling of Dynamic Systems (3) fall, 1983, and spring, 1985
Modeling of complex linear and nonlinear energetic dynamic engineering systems. Emphasis on subdivision into multiport elements and representation by the bondgraph language using direct, energetic, and experimental methods. Field lumping. Analytical and graphical reductions. Analog, digital and hybrid simulation. Examples including mechanisms, electromechanical transducers, electric and fluid circuits, and thermal systems. Prerequisite: ME 342 or ME 343 or ECE 212. Brown, Johnson

459. Advanced Systems Control (3)
Stochastic signals in estimation and optimal feedback control. Numerical techniques for nonlinear two-point boundary value problem. Stability and design criteria for nonlinear systems. Prerequisite: ME 448 (ECE 448). Brown, Johnson

460. Engineering Project (1-6)
Project work on some aspect of mechanical engineering in an area of student and faculty interest. Selection and direction of the project could involve interaction with local communities or industries. Prerequisite: consent of the department chairperson.

Undergraduate Courses In Mechanics

1. Statics (3) fall-spring
Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; centroids and centers of gravity; analysis of simple structures; internal forces in beams; friction; moments and products of inertia; methods of virtual work. Prerequisites: Math 22 and Phys 11.

11. Mechanics of Materials (3) fall-spring
Strength and elasticity of materials; theory of stresses and strains; deflection of beams and shafts; torsion; buckling of struts. Prerequisites: Mech 1; Math 23, previously or concurrently.

102. Dynamics (3) fall-spring
Kinematics and kinetics of particles and rigid bodies in two and three dimensions; relative motion; work and energy; impulse and momentum. Prerequisites: Mech 1 and Math 23.

103. Principles of Mechanics (4) spring
Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; friction. Kinematics and kinetics of particles and rigid bodies; relative motion; work and energy; impulse and momentum. Prerequisites: Math 23 and Phys 11.

104. Dynamics and Vibrations (3) fall
Kinematics and kinetics of particles and rigid bodies in two dimensions; relative motion; work and energy; impulse and momentum. Introduction to vibrations. For civil engineering students. Prerequisites: Mech 1 and Math 23.

For Advanced Undergraduates and Graduate Students

203. Advanced Strength of Materials (3) fall-spring
Elementary consideration of stress and strain at a point.

Stress-strain relations in two dimensions. Basic equations of motion. Classical theories of failures. Analysis of simple continuum systems with applications to materials behavior phenomena. Prerequisites: Mech 11 and Math 205.

302. Advanced Dynamics (3) spring
Fundamental dynamic theorems and their application to the study of the motion of particles and rigid bodies, with particular emphasis on three-dimensional motion. Use of generalized coordinates; Lagrange's equations and their applications. Prerequisites: Mech 102 or 103; Math 205. Beer, Sarubbi, Delph

305. Advanced Mechanics of Materials (3) fall
Selected problems of stress and strain that are governed by ordinary differential equations such as combined bending and torsion of bars, curved bars, beams and elastic foundation. Membrane analogy. Principles of indeterminate analysis. Energy methods. Prerequisites: Mech 203 or equivalent; Math 205.

307. Mechanics of Continua (3) spring
Fundamental principles of the mechanics of deformable bodies. Study of stress, velocity and acceleration fields. Compatibility equations, conservation laws. Applications to two-dimensional problems in the theories of perfectly elastic materials and also perfectly plastic materials. Prerequisites: Mech 203 and 305. G. Smith

313. Fracture Mechanics (3) spring
Fracture behavior in solids, the Griffith theory and extensions to linear elastic fracture process models; stress analysis of cracks; generalization of fracture criteria; plasticity; subcritical crack growth, including environmental and thermal effects; fracture toughness testing; failure analysis and fracture control plans. Prerequisites: Mech 11 and Math 205. Roberts, Sih, Wei

323. (CE 324) Fluid Mechanics of Ocean and Atmosphere (3) fall
Hydrostatics of the ocean and atmosphere. Vertical stability. Fluid motion in a rotating coordinate system. Geostrophic flow; ocean currents; surface and internal waves. Prerequisite: ME 231 or CE 121. Macpherson

326. Aerodynamics (3) spring
Application of fluid dynamics to external flows. Simple exact solutions in two dimensions. Kutta condition at a trailing edge. Thin aerofoil theory, steady and unsteady flow. Lifting line theory. Flow past slender bodies. Linearized compressible flow. Far field solutions, shock formation. Prerequisites: ME 231 and Math 208. Blythe

350. Special Topics (3)
A study of some field of engineering mechanics not covered elsewhere. Finite-element analysis has been offered recently. Prerequisite: consent of the department chairperson.

Graduate Program in Mechanics

The graduate courses in mechanics are open in general to students who have been graduated from a curriculum in engineering mechanics, engineering mathematics, engineering physics, civil engineering, or mechanical engineering at a recognized institution.

A candidate for the M.S. in applied mechanics is expected to possess a thorough knowledge of undergraduate mathematics and mechanics. Math 205, 208 and 322, and Mech 302 and 305, or their equivalents, are considered prerequisites for graduate work in applied mechanics. Any of these courses that have not been taken by the student as an undergraduate should be included in the graduate program. The student may then be required to present a larger number of credits than the minimum required for graduation. A thesis carrying six credit hours is required of all M.S. candidates.

Current departmental research activities of interest include programs as follows:

Continuum mechanics. Formulation of field equations and constitutive equations in non-linear elasticity theories. Mechanics of viscoelastic solids and fluids. Plasticity theory. Generalized continuum mechanics. Thermomechanical and electro-mechanical interactions. Stress birefringence. Wave propagation. Finite amplitude wave propagation.

Fracture mechanics. Stress anlaysis of media containing inclusions or perforations, including visco-elastic, non-homogeneous, and anisotropic materials. Analysis of crack growth under static, periodic, and random loadings and environmental effects. Optimizations of fracture control. Crack propagation theories for nonlinear materials. Influence of cracks on the strength of structural members.

Stochastic processes. Modeling of random behavior in mechanical systems. Static and time-dependent stochastic fracture mechanics.

Thin shell analysis. Free vibration and dynamics response of elastic shells. Elastic-plastic deformations of shells upon cyclic thermal loadings. Applications of shell analysis to nuclear power plant components (pressure vessels, curved pipes), and to biological systems (eye, frog's eggs and other cells).

Theoretical fluid mechanics. Vortex boundary layer interaction, modelling of turbulent boundary layers; geophysical flows such as frontal systems and mountain flows; statistical mechanics of plasmas, liquids and shock waves; finite amplitude waves in stratified gases and liquids; shock wave propagation; non-Newtonian flows in flexible tubes with application to hemorheology; magneto-fluid mechanics; wing theory; thermally driven flows.

Special departmental facilities of interest to the graduate student include the latest mechanical, electrodynamic and servocontrolled hydraulic testing machines, photoelastic bench, laser, and corrosion fatigue test facilities.

402. Advanced Analytical Mechanics (3)
Fundamental dynamical theorems and their applications to advanced problems; generalized coordinates; Lagrange's equations; fixed and moving constraints; nonholonomic systems; Hamilton's principle; Hamilton's canonical equations; contact transformations; Hamilton-Jacobi partial differential equation. Prerequisite: Mech 302 or consent of the department chairperson. Beer, Johnson

405. Response of Systems to Random Loads (3)
Stochastic processes; correlation functions and power spectra; response of mechanical systems to one-dimensional and multidimensional random load fields; probability of the random vibrations of mechanical systems; applications to failure prediction. Prerequisite: consent of the department chairperson. Harlow, Sarubbi

Mech 406. Advanced Dynamics and Vibrations (3) fall, 1984
Kinematical and mathematical preliminaries, basic notions of variational calculus; Hamilton's principle. Lagrange equations, discrete systems; dynamics of continuous systems. Sturm-Liouville theory, eigenvalue problems; transient and frequency response. There will be frequent examples of the application of these techniques to the analysis of shafts, beams, membranes, and plates. Prerequisites: ME 242 and Mech 302. Erdogan, Sarubbi, S. Johnson

407. Wave Propagation in Solids (3) spring, 1984
Wave propagation in deformable elastic solids; problems in half-space and layered media; application of integral transformations. Erdogan, Delph

409. Theory of Elasticity II (3) fall
Kinematics of deformation, analysis of stress, stress-strain

relations, strain energy function. Reciprocal theorem. Methods for two-dimensional boundary value problems applied to anti-plane, torsion, bending and plane problems. Approximate and numerical methods of solution. Prerequisites: Math 205; Mech 305 or equivalent course in advanced mechanics of material. Erdogan, Hartranft, Sih

410. Theory of Elasticity II (3)
Advanced topics in the theory of elasticity. The subject matter may vary from year to year and may include, e.g., theory of potential functions, linear thermoelasticity, dynamics of deformable media, integral transforms and complex-variable methods in classical elasticity. Problems of boundary layer type in elasticity; current developments on the micro-structure theory of elasticity. Prerequisites: Mech 409, Math 208, or consent of the department chairperson.

411. (Phys 471) Continuum Mechanics (3)
An introduction to the continuum theories of the mechanics of solids and fluids. This includes a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the theories to specific problems are given. G. Smith

412. Theory of Plasticity (3) spring, 1985
Time-independent mechanical behavior in simple tension, compression and torsion. Time-independent stress-strain relations for materials under combined stress. Application to problems with axisymmetric stress distributions. Loading, unloading, residual stresses, shakedown. Limit theorems of perfectly plastic bodies; applications. The slip line field for plane strain; examples. Plastic analysis of structures; frames, plates, shells. Finite element approach to problems. Time-dependent mechanical behavior of materials, creep. Prerequisites: Math 205; Mech 305 or equivalent course in advanced mechanics of materials. Kalnins, Updike

413. Fracture Mechanics (3) fall, 1984
Introduction to fracture mechanics criteria for bodies containing cracks and notches; microscopic and macroscopic analytical modeling; fracture toughness concept; test specimens; stress intensity factor evaluation of crack systems; prediction of crack trajectory and direction of initiation; dynamic loading and crack propagation; fatigue crack growth and environmental effects; brittle-ductile transition phenomenon in metals; visco-elastic behavior of polymers. Prerequisite: Mech 203, Math 208, or consent of the department chairperson. Erdogan, Sih, Wei

415. (CE 468) Stability of Elastic Structures (3)
Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilevel column. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Buckling by torsion and flexure. Variational methods. Buckling of frames. Instability problems of thin plates and shells. Prerequisite: Math 205. Kalnins

416. Analysis of Plates and Shells (3) fall, 1983, and spring, 1985
Bending of rectangular and circular plates, plates under lateral loads, plates with thermal and inelastic strains, effect of inplane forces, large deflections, buckling of plates. Geometry and governing equations of shells, shells of revolution, membrane states, edge solutions, solution by numerical integration, non-symmetric problems, buckling of shells, applications to pressure vessels. Prerequisites: Math 205; Mech 305, or equivalent course in advanced mechanics of materials. Kalnins, Updike

417. Mixed Boundary Value Problems in Mechanics (3)
General description of mixed boundary value problems in potential theory and solid mechanics. Solutions by dual series, dual integral equations and singular integral equations. Approximate and numerical methods. Erdogan

418. Finite Element Methods (3)
Finite element approximations to the solutions of differential equations of engineering interest are developed from variational principles or by Galerkin's method. Linear and nonlinear examples from heat transfer, solid mechanics, and fluid mechanics are used to illustrate applications of the method. The course emphasizes the development of computer programs to carry out the required calculations. Prerequisites: Knowledge of FORTRAN. Delph

419. Asymptotic Methods in the Engineering Sciences (3)
Introductory level course with emphasis on practical applications. Material covered includes: Asymptotic expansions. Regular and singular perturbations; asymptotic matching. Boundary value problems; distinguished limits. Multiple scale expansions. W.K.B. Theory. Far field theories. Asymptotic evaluation of integrals. Blythe

421. Fluid Mechanics (3)
Kinematics of fluid flow. Lagrangian and Eulerian descriptions. Basic conservation laws. Review of thermodynamics. Constitutive relations. Vorticity, circulation. Irrotational flow. Bernoulli theorems. Vortex motion, velocity motion, velocity potential, stream function. Potential flow in two and three dimensions. Compressible flow; sound waves, simple waves; gas dynamic discontinuities. Salathe

422. Fluid Mechanics (3)
Similarity and dimensional analysis. Exact solution for viscous incompressible flow. Singular perturbation theory, with application to flows at low and high Reynolds number. Hydrodynamic stability. Depending on interest, additional topics from magnetohydrodynamics, kinetic theory, wing theory, turbulence, water waves, flows in flexible tubes. Prerequisite: Mech 421. Salathe

424. Unsteady Fluid Flows (3)
Gas dynamics, finite amplitude disturbances in perfect and real gases; channel flows; three-dimensional acoustics; theories of the sonic boom. Motions in fluids with a free surface; basic hydrodynamics, small amplitude waves on deep water; ship waves; dispersive waves; shallow water gravity waves and atmospheric waves. Hemodynamics; pulsatile blood flow at high and low Reynolds number. Models of the interaction of flow with artery walls. Varley

437. (Met 437) Dislocations and Strengths in Crystals (3)
Theory and application of dislocations. Geometrical interpretation; elastic properties; force on a dislocation; dislocation interactions and reactions; multiplication. Dislocations in crystal structures. Selected topics in strengthening plastic flow, creep, fatigue and fracture are discussed. Prerequisites: Math 205 or 221, or Met 320; Met 317, or consent of the department chairperson. Chou, Wei

450. Special Problems (3)
An intensive study of some field of applied mechanics not covered in more general courses.

Metallurgy and Materials Engineering

Professors. Alan W. Pense, Ph.D., *chairperson,* R.D. Stout Professor; Betzalel Avitzur, Ph.D., director, Institute for Metal Forming; Sidney R. Butler, Ph.D.; Ye T. Chou, Ph.D.; George P. Conard II, Sc.D.; Joseph I. Goldstein, Sc.D., Theodore L. Diamond Professor and assistant vice president for research; Walter C. Hahn, Jr., Ph.D.; Richard W. Hertzberg, Ph.D., New Jersey Zinc Professor; Ralph J. Jaccodine, Ph.D., Sherman Fairchild Professor; R. Wayne Kraft, Ph.D.; Joseph F. Libsch, Sc.D. vice president for research (on leave, 1982-1983 academic year); Michael R. Notis, Ph.D.; Donald M. Smyth, Ph.D., director, Materials Research Center; Robert D. Stout, Ph.D., dean emeritus of the Graduate School and professor emeritus; S. Kenneth Tarby, Ph.D.; David A. Thomas, Sc.D., associate director, Materials Research Center; John D. Wood, Ph.D.
Associate professor. David B. Williams, Ph.D.
Assistant professor. Martin P. Harmer, Ph.D.

As science and technology advance in the 1980s and beyond, progress in many fields will depend on the discovery and development of new materials and a better understanding of existing materials. It is widely recognized that the progress of history has been divided into periods characterized by the materials that mankind has used, i.e., the stone age, the bronze age, the iron age. It is less widely recognized that continued progress will require new and better materials, processed in more complex ways, and with new kinds of properties.

Interest in new materials for solid-state devices, for application of nuclear energy and for space technology, as well as a better understanding of the behavior of materials in the design of structures, automobiles and aircraft, plant processing equipment, electrical machinery, etc., have increased the need for people trained in the science and technology of metals and other materials.

Training for this field of engineering requires basic studies in mathematics, chemistry, physics and mechanics, plus a general background in engineering principles, followed by intensive training in the application of scientific and engineering principles to the development and use of materials in a technological society. In addition, the curriculum offers an introduction to humanistic and social studies: these broaden the student's outlook and enhance professional development after graduation.

The objective of the program is to combine a fundamental understanding of the behavior of materials from the electronic, atomic, crystallographic, microstructural and macrostructural viewpoints with knowledge of the technology of materials preparation and processing. The student thus receives a broad education with emphasis on the factors that govern the structure and properties of materials to aid in the analysis, development, selection and use of materials for all types of industries.

The curriculum in metallurgy and materials engineering is designed to train graduates for research, development, operations, management and sales careers in industry or for graduate study in metallurgy and materials engineering. While some graduates go directly into materials-producing companies, a large proportion serve as metallurgists or materials engineers in the chemical, electrical, transportation, communications, space and other metal and materials consumer industries. A number of students pursue graduate study for university teaching and research careers.

Major Requirements

The recommended sequence of courses is shown. The standard freshman engineering year is shown on page 46.

sophomore year, first semester (17 credits)*

Math 23	Analytical Geometry and Calculus III (4)
Phys 21, 22	Introductory Physics II and Laboratory (5)
Eco 1	Economics (4)
Met 63 *or*	Engineering Materials and Processes *or*
Met 91 *or*	Elements of Materials Science *or* General Studies elective (3)
Met 10	Metallurgy Laboratory (1)

*Met 10 and Met 63 or 91 are required and should normally be taken during the sophomore year. However, they may be taken in the first semester of the junior year.

sophomore year, second semester (15-16 credits)

Math 205 *or*	Linear Methods *or*
Math 231	Probability and Statics (3)
ECE 81 *or*	Principles of Electrical Engineering *or*
Phys 31	Introduction to Quantum Mechanics (3-4)
Mech 1	Statics (3)
	General Studies elective (3)
Met 63 *or*	Engineering Materials Science *or*
Met 91	Elements of Materials Science *or* General Studies elective (3)

junior year, first semester (18 credits)

ChE 60	Unit Operations (3)
Chem 207	Metallic Elements (3)
Mech 11	Mechanics of Materials (3)
Met 207	Electronic and Crystal Structure (3)
Met 210	Metallurgical Thermodynamics (3)
	General Studies elective (3)

junior year, second semester (17-18 credits)

ME 166 *or*	Procedures for Mechanical Design *or*
Mech 102	Dynamics (2-3)
Met 101	Professional Development (2)
Met 208	Phase Diagrams and Transformations (3)
Met 218	Mechanical Behavior of Materials (3)
Met 304	Extractive Metallurgy I (4)
	elective (3)

summer

Met 100	Summer Employment

senior year, first semester (15-18 credits)

Met 305	Extractive Metallurgy II (3)
Met 307	Materials Engineering I (3)
Met 313	Materials Fabrication (3)
	engineering science elective (3)**
	elective (3-6)*

senior year, second semester (15-18 credits)

Met 278	Metallurgical Reports (3)
Met 308	Materials Engineering II (3)
	engineering science elective (3)**
	approved elective (3)
	General Studies elective (3)
	elective (0-3)*

*Please refer to description of normal program, page 46.
**Engineering science electives are selected from a list available in the department office.

In addition to the regular program, there are two options in the curriculum oriented to emphasize the following: industrial metallurgy, and preparation for graduate research in materials.

Industrial Metallurgy Option

The industrial metallurgy option is designed to prepare students in a four-year program as plant metallurgists or materials engineers. To assist in this objective, students electing the option take two special courses, Met 327 and 329, in place of an equivalent number of other specified courses. The emphasis in these courses is a team approach to the solution of actual plant problems.

The course is conducted in cooperation with local industries. Three days per week are spent at the plant of the cooperating industry on investigations of selected problems in plant operations. The option is limited to a small group of seniors, selected by the department from those who apply. Summer employment is provided when possible for those who elect to initiate the program during the summer preceding the senior year.

junior year
same as regular program

summer
Met 100 Industrial Employment

senior year, first semester (17-20 credit hours)
Met 327 Industrial Metallurgy (4)
Met 329 Industrial Metallurgy (4)
Met 305 Extractive Metallurgy II (3)
Met 307 Materials Engineering I (3)
Met 313 Materials Fabrication (3)
elective (0-3)*

senior year, second semester (17 credit hours)
Met 338 Metallurgy Colloquium (2)
Met 308 Materials Engineering II (3)
Approved elective (3)
General Studies elective (3)
engineering science elective (6)**

*Please refer to description of normal program page 46.
**Engineering science electives all selected from a list available in the department office.

Research Option

For those students who may be interested in teaching, research, or development, and intend to pursue graduate work, a research option is offered. In this option, students take Met 240 and 291. Financial support may be available for those students who elect to initiate a research program during the summer preceeding the senior year. The option is limited to a small group of selected students.

junior year, second semester (19-20 credits)
same as regular program with the following addition:
Met 240 Research Techniques (2)

summer
Met 100 *or* Industrial Employment *or*
Undergraduate Summer Research

senior year, first semester (15-18 credit hours)
Met 291 Experimental Metallurgy (3)
Met 305 Extractive Metallurgy II (3)
Met 307 Materials Engineering I (3)
Met 313 Materials Fabrication (3)
elective (3-6)*

senior year, second semester (17 credit hours)
Met 338 Metallurgy Colloquium (3)
Met 308 Materials Engineering II (3)
Approved Elective (3)
General Studies elective (3)
engineering science elective (6)**
*Please refer to description of normal program, page 46.
**Engineering science electives all selected from a list available in the department office.

Undergraduate Courses

10. Metallurgy Laboratory (1) fall
Application of equipment for laboratory study of structure and properties of metals. Prerequisite: Met 63 or 91 previously or concurrently.

63. Engineering Materials and Processes (3) fall-spring*
Engineering materials and their properties. Methods and effect of fabrication and treatment. Application and use of materials in engineering. Primarily metals, but including plastics, ceramics, and other engineering materials. Prerequisites: Chem 21; Phys 11.

91. Elements of Materials Science (3) fall-spring*
Introductory study of the relationship between structure (on the atomic, crystallographic or molecular, micro and macro scales) and physical and mechanical properties of metallic, ceramic, and polymeric materials. Influence of processing variables on structure and properties. Lectures and recitation. Prerequisites: Chem 21; Phys 21 previously or concurrently.

92. Structure and Properties of Materials (3) spring*
A unified chemical-physical approach to the structure and properties of metallic, nonmetallic and composite materials of construction. Laboratories and lecture examples emphasizing structure, mechanical properties, and materials applications. Prerequisites: Chem 21, Phys 21. Thomas
**Only one of these courses may be applied for graduation credit by each student.*

100. Industrial Employment
In the summer following the junior year, students in metallurgy and materials engineering are required to secure at least eight weeks of experience in industrial plants or research organizations. A written report is required.

101. Professional Development (2) spring
Seminar on the role and purpose of engineering in society; the meaning of being a professional; the role of creativity, communications and decision making in the engineering process; expectations and problems of young engineers; personal goals; choosing a career. Required reading. Written reports based on library research. Prerequisite: junior standing.

For Advanced Undergraduates and Graduate Students

204. Nonmetallic Materials of Construction (3) fall
The principles and technology of nonmetallic materials of present and future use in structural applications. Manufacturing methods and mechanical and environmental properties, with emphasis on composite materials such as concrete, fiber-reinforced and foamed polymers, and laminates. Lectures and some field trips or laboratories. Prerequisite: Met 92 or equivalent. Thomas

207. Electronic and Crystal Structure (3) fall
Atomic theory, chemical bonding, lattice concepts, and theory of X-rays. Nature of crystalline phases, imperfections, and atom movements. Electron theories of solids. Lectures and laboratory. Prerequisites: Met 10, previously or concurrently, and Phys 21. Goldstein, Notis

208. Phase Diagrams and Transformations (3) spring
Thermodynamic basis for equilibrium. The phase rule. Equilibrium phase diagrams and nonequilibrium considerations. Solidification and solid-state phase changes. Rationalizations of microstructures. Recovery, recrystallization, and grain growth. Lectures and laboratory. Prerequisites: Met 63 or 91; Met 207 and Met 210. Conard, Williams

210. Metallurgical Thermodynamics (3) fall
The applications of thermodynamic relations to metallurgical processes with emphasis on solving specific problems for processes such as metal refining, heat treating atmospheres, alloy equilibrium diagrams, and others. Lectures and problem sections. Prerequisite: Math 23. Hahn

213. Materials Systems Analysis (3)
Study of application of materials science principles to the solution of materials engineering problems. Interrelation between basic concepts and the selection of complete materials systems, which consist of the fabricating process and finishing sequence, for particular design requirements. Materials covered will be metals, polymers, ceramics and composites. Not open to majors in metallurgy and materials engineering. Lecture and laboratory. Prerequisite: Met 63 or 91 or equivalent of either course. Wood

215. Processing and Properties of Ceramic Materials (3)
An introductory-level course on ceramic materials with emphasis on processing. Basic science of ceramic fabrication technology including glass, refractories, and ceramic coatings. Structure of oxides including clay minerals. Methods of characterization. Electrical, magnetic thermal and mechanical properties of ceramic products. Prerequisites: Chem 21, Phys 11 and Met 63 or 91. Harmer

218. Mechanical Behavior of Materials (3) spring
Deformation and fracture behavior of materials. Elastic and plastic behavior, with emphasis on crystallographic considerations. Strengthening mechanisms in solids. Static and time-dependent fracture from metallurgical and continuum viewpoints. Lectures and laboratory. Prerequisites: Mech 11, Met 207, and Met 63 or Met 91. Hertzberg

221. (STS 221) Materials in the Development of Man (3)
Development of materials technology and engineering from the stone age to atomic age as an example of the interaction between technology and society. In-class demonstration laboratories on composition and structure of materials. Term projects using archaeological materials and alloys. Course intended for, but not limited to, students in the humanities and secondary science education. Engineering students may not use this course for engineering science or technical elective credit. Notis

240. Research Techniques (2-3) spring
Study, analysis and application of experimental techniques in metallurgical and materials research. Analysis of experimental data and methods of presentation. Design of experimental programs. Recitations and laboratory. Restricted to small numbers of students selected by the department chairperson.

278. Metallurgical Reports (3) spring
An opportunity for the advanced student to develop familiarity with current metallurgical literature and to present oral reports and a comprehensive written survey. Prerequisite: senior standing.

291. Experimental Metallurgy (3)
Application of research techniques to project in metallurgy or materials engineering selected in consultation with the senior staff. Prerequisite: Met 240.

300. Apprentice Teaching in Metallurgy (1-3)
See the introduction to Section V for an explanation.

304. Extractive Metallurgy I (4) spring
A unit process study of extractive metallurgy techniques. Includes chemical principles, thermochemistry and kinetics; also phases in pyrometallurgical systems, combustion of fuels and refractories. The preparation, treatment, and handling of materials for primary crude metal production. Lectures plus laboratory. Prerequisite: ChE 60, Met 210, and Engineering I or equivalent. Hahn

305. Extractive Metallurgy II (3) fall
Continuation of Met 304. A detailed engineering analysis of important metallurgical processes. A study of the thermodynamic and kinetic aspects of these processes. Development of mathematical models of processes by computer programming. Lectures, laboratory and plant trips.Prerequisite: Met 304. Tarby

306. Optimization of Metallurgical Processes (3)
Numerical methods are used to investigate metallurgical reactions and processes. Problems relating to the optimization of processes in the ferrous and nonferrous fields are studied. Lectures and computer-oriented problems. Prerequisites: a knowledge of computer programming and consent of the department chairperson. Tarby

307. Materials Engineering I (3) fall
Selection of fabrication sequences for ceramic, metallic and plastic materials. Correlation of structure and properties of ferrous alloys including design of thermal treatments. Lectures plus laboratory, which includes designing and conducting original experiments to solve materials engineering problems. Term project on selecting manufacturing sequences. Plant visits. A three-day inspection trip is required. Prerequisite: Met 208. Pense, Wood

308. Materials Engineering II (3) spring
Continuation of Met 307. Correlation of structure and properties of ceramic and plastic materials. Design of nondestructive evaluation systems. Engineering to minimize environmental degradation of materials. Selection of materials and processing to solve specific engineering problems. Failure analysis. Lectures plus laboratory, which involves development and execution of experimental project to solve engineering problems. Term project on selecting material systems. Plant visits. Prerequisites: Met 307. Wood, Pense

311. Metallic Materials for Structures (3) fall
The structure and behavior of structural steels, aluminum and other alloys, with emphasis on materials used in large-scale engineering structures such as bridges, buildings and pressure vessels. Fracture mechanics concepts, the physical metallurgy of alloys involved, and fabrication of structures, especially welding. The relationship between materials, fracture control and fabrication. Metallurgy majors may take only with the consent of the department chairperson. Lectures and laboratory. Prerequisite: Met 63 or equivalent. Hertzberg, Pense

312. (ChE 312) Fundamentals of Corrosion (3)
Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization, and passivity. Nonelectrochemical corrosion including mechanisms, theories and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisites: Met 210, Chem 187, or equivalent of either.

313. Materials Fabrication (3) fall
Basic concepts of stress, strain and stress-strain behavior under load. Analysis and description of metal forming, metal cutting, casting, joining and powder metallurgy. Lectures and laboratory. Prerequisite: Met 63 or Met 91, or equivalent. Avitzur

314. Advanced Metal Forming (3)
Extension of Met 313. Topics to be included: friction,

lubrication and wear, failure and damage in metal forming, and deformation in composite metals and in powder metallurgy. Forming alternatives for specific products such as cans, tubes, wires and others will be compared. Recent developments of new forming processes. Prerequisite: Met 313. Avitzur

315. Introduction to Physical Ceramics (3)
Methods of fabrication, physical properties, and applications of ceramic material, including oxides, carbides, nitrides, borides and silicides. Correlation of atomic bonding, microstructure and physical behavior in service environments. Special topics, including electronic ceramics, nuclear ceramics, refractories, cutting tools and abrasives. Prerequisites: Chem 21 and Phys 11 or consent of the department chairperson. Harmer

316. Physical Properties of Materials (3)
Consideration of observed electrical, magnetic, thermal and optical properties of crystalline materials with emphasis on their relationship to electron configuration and crystal structure. Lectures and demonstrations. Prerequisite: Met 207 or Phys 31, or consent of the department chairperson. Notis, Conard or Butler

317. Imperfections in Crystals (3)
The types of imperfections in crystals and their effects on the behavior of crystalline materials with particular emphasis on dislocations. Prerequisite: Met 63 or 91, or equivalent. Chou

319. Current Topics in Materials Science (3)
Selected topics of current interest in the field of material engineering but not covered in the regular courses. May be repeated for credit with consent of the department chairperson. Prerequisites: Met 210 and 218.

320. Analytical Methods in Materials Science (3)
Selected topics in modern anaylsis and their application to materials problems in such areas as thermodynamics, crystallography, deformation and fracture, diffusion. Prerequisite: Math 231 or 205. Chou

321. (ECE 305) Failure Analysis of Semiconductor Devices (3)
Fundamental degradation and failure mechanisms that affect the reliability of seminconductor devices. The use of scanning and transmission electron microscopy to examine these mechanisms. Lectures and laboratory. Prerequisite: consent of instructor. Norian

322. Materials Technology in the Energy Crisis (3) spring
Impact of materials on energy including nuclear and solar energy and solar cells, coal gasification, MHD power generation and superconductors. Energy resources, conversion, and consumption. Materials limitations on development of energy alternatives in transporation, power and primary metals industries. Industry and government lecturers participate. Prerequisite: Met 63 or 91, or consent of the deparment chairperson. Notis

323. (ECE 303) Electrical and Physical Characterization of Defects in Semiconductors
Basic concepts of solid-state physics applied to P-N junction theory. Topics will include influence of material growth techniques on defect origination; dislocations induced by diffusions; oxidation-induced stacking faults; the role of imperfections on pipe leakage and soft breakdowns. The relation of materials, defects and processing will be highlighted. Jaccodine

327. Industrial Metallurgy (4) fall
Restricted to a small group of seniors and graduate students selected by the department from those who apply. Three full days per week are spent at the plant of an area industry for research in plant operations. Application by a graduate student for admission to this course must be made prior to March 1 of the previous semester. Tarby, Hahn, Notis

329. Industrial Metallurgy (4) fall
To be taken concurrently with Met 327. Course material is the same as Met 327.

333. (Geol 337) X-ray Methods (3) fall
Fundamentals and experimental methods of X-ray techniques. Application to various materials problems including diffraction, radiography, fluorescent analysis. Lectures and laboratory work. Prerequisites: Phys 21 and Met 91 or equivalent. Conard, Kraft

334. (Geol 338) Electron Metallography (4) spring
Fundamentals and experimental methods in electron optical techniques included scanning electron microscopy (SEM) conventional transmission (TEM) and scanning transmission (STEM) electron microscopy. Specific topics covered will include electron optics, electron beam interactions with solids, electron diffraction and chemical microanalysis. Applications to the study of the structure of materials are given. Prerequisite: consent of the department chairperson. Williams, Goldstein

338. Metallurgical Colloquium (2) spring
An opportuity for the student to develop an acquaintance with the current metallurgical literature, the ability to interpret such literature clearly, and skill in presenting oral engineering reports. Prerequisite: consent of the department chairperson.

343. (ChE 393, Chem 393) Physical Polymer Science (3)
Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline and paracrystalline states (including viscoelastic and relaxation behavior) for single and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology and behavior. Prerequisite: one year of physical chemistry.

345. Nondestructive Evaluation (3)
Scientific fundamentals and engineering applications of nondestructive evaluation methods including penetrant, magnetic particle, eddy-current, radiographic, ultrasonic and acoustic-emission inspection techniques. Recent developments in nondestructive inspection of materials. Lectures and labs. Prerequisites: Met 63 or equivalent, senior standing. Wood

361. Physics of Materials (3)
Principles of quantum mechanics and statistical thermodynamics. Intended to provide a basic understanding of the principles underlying the study of structure and properties of materials. Prerequisites: Met 91 or equivalent; Math 205.

396. (Chem 396) Chemistry of Nonmetallic Solids (3)
Chemistry of ionic and electronic defects in nonmetallic solids and their influence on chemical and physical properties. Intrinsic and impurity-controlled defects, nonstoichiometric compounds, defect interaction. Properties to be discussed include; diffusion, sintering, ionic and electronic conductivity, solid-state reactions, and photoconductivity. Prerequisite: Chem 187 or Met 210 or equivalent. Smyth

For Graduate Students

The department offers three degrees; a master of science, a master of engineering, and a doctor of philosophy in metallurgy and materials engineering.

While a diversity of program and curricula are available to a person interested in graduate study in the area of materials, the department of metallurgy and materials engineering generally is the department from

which a degree is earned. However, thesis and dissertation research may be a part of programs under way in the department or at the Materials Research Center or other departments or centers.

The department has a large enough staff and graduate enrollment to enable it to suit the needs of students whose interests range from the science of materials through materials engineering and metallurgy. At the same time, those advanced students who want experience in teaching are able to teach under the guidance of the senior staff.

The foundation for successful graduate work in the department includes sound preparation in chemistry, physics and mathematics, and adequate breadth of general education. Candidates entering the department who have obtained their previous degrees in fields other than metallurgy or materials engineering may be required to take certain undergraduate courses without credit toward the graduate degree.

The programs of the department are flexible. Upon acceptance, each student is assigned a faculty adviser. Under the adviser's direction, the student plans a course of study to satisfy individual needs and interests.

Most advanced-degree recipients find careers in industry or industrial or governmental research and development laboratories. A smaller number have gone into teaching, consulting or academic research.

Graduate facilities for research are located in the Whitaker Laboratory, in the interdisciplinary Materials Research Center, the Sherman Fairchild Laboratory, and other associated laboratories. The laboratories are well equipped with both generalized equipment as well as specialized sophisticated equipment which is available to graduate students.

Specialized equipment such as conventional and scanning transmission electron microscopes, scanning electron microscopes, electron microprobe, X-ray diffraction units, closed-loop mechanical testing equipment, and crystal-growing and zone-processing equipment are maintained and operated by skilled technicians. After receiving the required instructions, graduate students operate this equipment.

Departmental facilities are supplemented by a computer system and the Mart Science and Engineering Library.

Special Programs and Opportunities

The department has established specific recommended programs for the M.S., the M. Eng., and the Ph.D., emphasizing the following areas: chemical metallurgy, materials engineering, materials science, mechanical metallurgy, physical ceramics, and physical metallurgy.

These programs are not rigid. The program in chemical metallurgy offers a cooperative program with the chemical engineering department. The emphasis of the mechanical metallurgy program is on the analysis of metal-forming operations. Many students, however, have specialized in other areas of mechanical metallurgy, such as deformation and fracture analysis, either through combined programs in physical and mechanical metallurgy or through cooperation with the department of mechanical engineering and the Materials Research Center. The physical ceramics program emphasizes the study of the mechanical and physical behavior of various ceramic systems. The study of solid-state materials for electronic applications is done in cooperation with the Sherman Fairchild Laboratory. The department also cooperates with the chemical engineering and chemistry departments in graduate programs in polymer science.

Major Requirements

The Graduate School requirements are explained in Section IV. In the department of metallurgy and materials engineering, a candidate for the M.S. completes a thesis. This normally represents six of the thirty semester hours required for this degree. Candidates for the M.Eng. complete a three-credit engineering project.

A candidate for the Ph.D. prepares a preliminary program of course and research, providing for specialization in some phase of metallurgy, materials science, or materials engineering (largely through research) in consultation with the adviser. Prior to formal establishment of the doctoral program by the special committee and its approval by The Graduate School, the student passes a qualifying examination that must be taken early in the first year of doctoral work. The department does not require a foreign language. It does require preparation and defense of a research proposal as a portion of the general examination.

Of the courses listed above only those in the 300 series are available for graduate credit for students in metallurgy and materials engineering. There are many additional offerings in materials under the listings of other departments.

Most graduate students receive some form of financial aid. Several kinds of fellowships, traineeships, and assistantships are available. This type of aid generally provides for tuition, and allowance for experimental supplies, and a stipend. To date, the Internal Revenue Service has allowed this stipend to be tax-free. For details of graduate scholarships, fellowships and assistantships, please refer to Section IV.

Research Activities

Graduate students conduct their research in facilities located in the department or the Materials Research Center, or other centers and institutes. The following list of activities notes the many areas of interest. Asterisks (*) indicate research of an interdisciplinary nature.

Chemical metallurgy. Kinetics of metallurgical reactions; mathematical modeling of metallurgical processes; thermodynamics of metallic solutions; thermodynamics and phase equilibria.

Materials science. Characterization of metal oxide films*; crystal growth*; defect chemistry and electrical properties of insulating and semiconducting oxides*; deformation and recrystallization texture studies; growth and deformation of bicrystals; dislocation studies; magnetic materials; meteorites and lunar materials; photoelectric studies of insulators; preparation and properties of materials for solid-state devices*; processing of metal insulator semiconductor structures and their evaluation and application to integrated circuits*; quantitative metallography; structure and behavior of solid-state materials*; structure and properties of sputtered, evaporated, and plated thin films*.

Mechanical metallurgy. Cladding and forming of composite materials; correlation of microstructure with mechanical behavior of low-alloy, high-strength steels, especially fatigue, creep and brittle fracture, deep drawing, impact extrusion and ironing; deformation and fracture of eutectic composites; ductile fracture; effect of holes, inclusions and pressure on the tensile properties; electron fractography*; environmental crack kinetics*; fatigue crack propagation studies of metals and polymers*; flow through converging conical dies; forming of polymers*; friction measurement; hydrostatic extrusion; influence of welding on fatigue characteristics of weldments*; mechanical behavior of anisotropic materials*; pressure-induced ductility; theoretical analysis of metal-forming methods and correlation with metallurgical parameters; toughness of weld metal; weldability of steels.

Physical ceramics. Electrical properties of electronic ceramics*; thermal diffusivity of ceramic materials*; hot pressing studies*; grain growth in oxides*; electrical and magnetic properties of oxides*; creep modeling of ceramics*; electron microscopy of dislocation structures*; defect chemistry and electrical properties of ceramic oxides*.

Physical metallurgy. Computerized materials selection; creep-rupture and aging, brittle fracture characteristics and fatigue properties of low-alloy, high-strength steels*; diffusion-controlled growth; embrittlement mechanisms in steel; kinetics of solid-state

reactions*; metallurgical factors affecting machining*; physical metallurgy of aluminum alloys; sintered carbides*; recrystallization; strengthening mechanisms; structure and morphology of martensite; tempering, ternary diffusion; transformation during joining; transmission electron microscopy of crystal defects; X-ray measurement of residual stresses*.

Polymers. Environmental effects on polymers*; fatigue crack propagation in engineering plastics*; fracture surfaces of crystalline polymers*; ion transport in polymer membranes; mechanical behavior of interpenetrating networks*; mechanical behavior of polyvinyl chloride*; mechanisms of sintering of polymers*; micromechanics of polymer fracture*; polymers from renewable resources; properties of polymer composites*; reclamation of scrap polymeric materials*; reinforcement of silicone rubber by silica fillers*; second-order transitions in cellulose triesters.

Graduate-Level Courses

406. Solidification (3)
Structure, theory and properties of liquids. Homogeneous and heterogeneous nucleation theory and experimental results. Solidifcation phenomena in pure, single and multiphase materials including the natures of the freezing interface, segregation, constitutional super-cooling, dendritic growth, crystallographic effects, the origin of defects, crystal growing, zone processes. Prerequisite: consent of the chairperson. Kraft

407. Theory of Alloy Phases (3)
Equilibrium portrayal and prediction. For the former, the emphasis is on systems of three of more independent variables. For the latter, consideration is given to the various factors, both "physical" and thermodynamic, which influence, and may permit prediction of, equilibrium phase structures and their range of stability. Examples are considered of the extension of such approaches to property prediction. Prerequisite: An undergraduate course in equilibrium diagrams, e.g. Met 208. Conard

408. Transformations (3) fall
The thermodynamics, kinetic and phenomenological aspects of a wide spectrum of solid-state phase transformations. Theories of nucleation, growth and coarsening of second-phase precipitates. Application of the theories to continuous and discontinuous reactions, massive, martensitic and bainitic transformations in metals. Transformations in non-metallics. Prerequisites: Met 208 and 210 or equivalent. Williams

409. Current Topics in Materials (3)
Recent practical and theoretical developments in materials. This course may be repeated for credit if new material is covered. Prerequisite: consent of the department chairperson.

410. Physical Chemistry of Metals I (3) fall
Discussions of reactions involving gases and reactions involving pure condensed phases and a gaseous phase. Ellingham diagrams and equilibria in metal-oxygen-carbon systems. Consideration of the behavior of solutions and methods for determining thermodynamic properties of solutions by experimentation and computation. Prerequisite: Met 210 or equivalent. Tarby

411. Modern Joining Methods (3)
The foundations upon which the joining processes rest; the present limitations of the various processes; the trends in new developments; the engineering and structural aspects of joining. Prerequisites: Met 208 and 218 or equivalent. Pense

412. Magnetic Properties of Materials (3)
Fundamental concepts of magnetism and magnetic properties of ferro- and ferrimagnetic materials. Metallic and nonmetallic materials. Current application areas considered as examples. Prerequisite: Phys 31 or 363 or equivalent. Butler, Conard, Notis

413. Analysis of Metal Forming Processes (3)
Three-dimensional stress and strain analysis. Yield criteria, plastic flow and the upper and lower bound theorems. Analysis of metal forming processes, including drawing and extrusion, press work, rolling and spinning. The emphasis is on presenting several approaches to each problem. Avitzur

414. Physical Chemistry of Metals II (3) spring
Presentation of free energy-composition and phase diagrams of binary systems. Evaluation of lattice stability parameters. Consideration of reaction equilibria in systems containing components in condensed solutions, including compound formation, oxide phases of variable composition, solubility of gases in metals. Alternative standard states and interaction parameters for solutions. Prerequisite: Met 410. Tarby

415. Mechanical Behavior of Ceramic Solids (3)
Strength, elasticity, creep, thermal stress fracture, hardness, abrasion and high-temperature deformation characteristics of single- and multi-component brittle ceramic solids. Statistical theories of strength, static and cyclic fatigue, crack propagation, fracture toughness. Correlation of mechanical behavior, microstructure, and processing parameters. Prerequisite: Met 218 or consent of the department chairperson. Notis, Harmer

416. Atom Movements (3)
Phenomenological and atomistic development of the laws of diffusion and their solution. Influence of gradients of concentration, potential, temperature and pressure. Effects of structural defects on diffusion in metals and nonmetals. Prerequisites: Math 23 and Chem 196 or the equivalent. Butler, Hahn

417. Deformation and Strength of Solids (3)
Topics related to deformation of solids including creep, strengthening mechanisms, annealing of deformed solids, preferred orientation. Primary emphasis is on crystalline materials. May be repeated for credit if different material is covered. Prerequisite: Met 218 or equivalent. Chou, Conard, Hertzberg, Kraft or Notis

418. Fatigue and Fracture of Engineering Materials (3) fall
Application of fracture mechanics concepts to the fatigue and fracture of crystalline and amorphous solids. Fracture control design philosophies. Metallurgical aspects of fracture toughness and embrittlement susceptibility. Environment-enhanced cracking. Fatigue crack propagation in metals and polymers. Electron fractography. Failure anaylsis case histories. Prerequisite: Met 218 or equivalent. Hertzberg

419. Alloy Steels (3)
Structures and transformations in iron and iron-based alloys. Design and heat treatment of alloys of strength, toughness, creep, and corrosion resistance. Prerequisite: Met 307 or equivalent. Pense

421. Fracture Analysis (3)
Application of fracture mechanics concepts, microstructural analysis, and facture surface characterization to the analysis and prevention of engineering component failures. Extensive use of case histories. Introduction to legal aspects of product liability. Prerequisite: Met 218 or 311 or Mech 313 or equivalent. Hertzberg

422. Electrical Properties of Materials (3)
Electrical transport properties of metallic, semiconducting and insulating materials. Brief review of energy band concepts including surface and contact effects. Photo

conduction and contact phenomena. Prerequisite: Phys 31 or 363 or equivalent. Butler, Conard, or Notis

423. Advanced Transmission Electron Microscopy (3)
The theory and practice of operation of the transmission and scanning transmission electron microscope. Techniques covered include bright field, high resolution and weak-beam dark field, lattice imaging, diffraction pattern indexing and Kikuchi line analysis. The theory of diffraction contrast is applied to the interpretation of electron micrographs. Specimen preparation techniques. Prerequisite: Met 334 or equivalent. Williams

425. Topics in Materials Processing (3)
Topics such as: ceramics, metal, and polymer synthesis and compaction phenomena. Theories of sintering and grain growth. Physical behavior of sintered compacts. Techniques of fiber and crystal growth. Vapor deposition and ultra-high-purity materials preparation. Desirable preparation: Met 208, 218, 315. Prerequisite: consent of the department chairperson.

427. Advanced Scanning Electron Microscopy (3)
The theory and practice of operation of the scanning electron microscope and electron microprobe. Techniques covered will include high-resolution scanning, quantitative electron probe microanalysis. Electron beam sample interactions, X-ray spectrometry, and electron optics will be discussed indetail. Prerequisite: Met 334 or equivalent.

437. (Mech 437) Dislocations and Strength in Crystals (3)
Theory and application of dislocations. Geometrical interpretation; elastic properties; force on a dislocation; dislocation interactions and reactions; multiplication. Dislocations in crystal strctures. Selected topics in strengthening, plastic flow, creep, fatigue and fracture are discussed. Prerequisites: Math 205 or 221, or Met 320; Met 317, or consent of the department chairperson. Chou, Wei

443. (Chem 443) Solid-State Chemistry (3)
Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids, dielectrics, surface states and surface fields in crystals. Prerequisite: Chem 191 or equivalent. Smyth

458. Materials Design (3)
Analysis of design requirements for materials components. Selection of materials and processes. Study of failures in process and service and application of recent metallurgical and materials engineering knowledge for improved design. Solution and discussion of industrial problems, and outline of experimental approach. Prerequisite: consent of the chairperson. Wood

460. Engineering Project (1-3)
In-depth study of a problem in the area of materials engineering or design. The study is to lead to specific conclusions and be embodies in a written report. Intended for candidates for the M.Eng. May be repeated for a total of three credit hours.

461. Advanced Materials Research Techniques (3)
Study of the theory and application of selected advanced techniques for investigating the structure and properties of materials. May be repeated for credit with the approval of the department chairperson.

482. (Chem 482, ChE 482) Engineering Behavior of Polymers (3) spring
A treatment of the mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture and aging on mechanical behavior.

484. (Chem 484, ChE 484) Crystalline Polymers (3) spring
An in-depth treatment of the morphology and behavior of both polymer single crytals and bulk crystallized systems. Emphasis is placed on the relationship between basic crystal physics, thermal and annealing history, orientation and resulting properties. A detailed discussion of the thermodynamics and kinetics of transition phenomena and a brief treatment of hydrodynamic properties and their relationship to crystallization and processing properties. Prerequisites: ChE 392 or 393 or equivalent.

485. (Chem 485, ChE 485) Polymer Blends and Compositions (3) fall
An intensive study of the synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnted concrete, and fiber and particulate reinforced polymers are emphasized. Prerequisite: any introductory polymer course or equivalent.

Military Science

Professor. Lt. Col. Robert J. Freund, M.A., M.S.B.A., *chairperson.*
Assistant professors. Major James F. Mesite, Jr., B.S.; Major Michael J. Fiorito, M.A.; Major David P. Parkin, M.S.; Capt. Bruce K. Zophy, B.S.
Instructors. Sgt. Maj. Ronald D. Prevost, B.A.; M. Sgt. Keith L. Creamer; SFC Anthony L. Woolum.

The department of military science, established at Lehigh in 1919, offers courses supporting the Army Reserve Officer Training Corps (ROTC) program. This course material is designed to develop innate leadership and management ability and provide a fundamental understanding of the Army's organization and responsibilities in our society and as part of our national defense forces.

These objectives are approached by utilizing academic classroom instruction, leadership laboratory, and adventure-type field trips. The leadership laboratory and field trips are both enjoyable and beneficial. A concept of modular electives has been instituted that permits students to select the activity that most interests them. The following modules are presently available: rifle marksmanship;mountaineering; conflict simulations; orienteering; self-defense; and physical readiness. Voluntary field trips in all of the activities are conducted throughout the year.

Army ROTC offers a four-year program and a two-year program. The four-year program consists of a two-year basic course and a two-year advanced course. The two-year program consists of the two-year advanced course; this program is offered to students with previous military experience and those who have successfully completed a six-week basic summer camp. Basic course students incur no obligation for service in the Army as a result of taking these courses.

Basic course. The basic course, normally taken in the freshman and sophomore years, provides training in basic military subjects, such as, the Army's role and organizational structure, leadership and management, basic tactics, land navigation and first aid.

Advanced course. The advanced course is normally taken in the junior and senior years. The instruction includes management, military skills, advanced tactics, logistics, administration, military law, ethics, and professionalism. Students receive $100 per month subsistence pay during the junior and senior years.

A six-week advanced course summer training camp is normally held between the junior and senior year. Payment to the student for attending this camp is $800 plus travel expenses. The summer camp experience, in coordination with respective engineering curricula, may be used to fulfill the requirements of the engineering courses ChE 100, CE 100, EE 100, IE 100, ME 100, and Met 100, Industrial Employment.

To enroll in the advanced course, an applicant: completes either the basic course or the six-week basic summer camp; or has received basic course credit for previous military experience; and is accepted for enrollment by the university and the department of military science.

Uniforms and equipment. All uniforms, textbooks and equipment needed by the student for military science courses are supplied by the department. Students are charged only for those items not returned when they leave the program.

Transfers. Qualified students transferring from another institution may enter the ROTC program at the appropriate advanced level and year, provided they have received the necessary credits, the recommendation of their former professor of military science (if applicable), and the approval of the university.

Obligation after graduation. Usually upon graduation a student will receive a reserve commission as a second lieutenant and will serve on active duty for three years. Depending on Army requirements, a three- to six-month active duty for training period with an eight-year reserve commitment is offered. Recipients of a Regular Army commission serve at least three years on active duty. Scholarship students agree to accept a Regular Army commission if offered and serve four years on active duty. Graduates accepted for the Army aviation program serve at least three years on active duty after completing studies at the Army Aviation School at Fort Rucker, Ala.

Graduate studies. Under normal circumstances, ROTC graduates may delay their active service to pursue a full-time course of instruction leading to an advanced degree. Delay does not lengthen the active service obligation unless the degree is obtained at government expense.

Course credit. Students in the College of Arts and Science and the College of Business and Economics may substitute military science advanced credits for six hours of electives. In the College of Engineering and Physical Sciences, six credits of advanced ROTC work are permissible within the normal program of each student, irrespective of curriculum. For curricula that include more than six hours of personal electives in the junior and senior years, inclusion of the more than six hours of ROTC credit with normal programs can be effected only with the approval of academic advisers. Two credit hours may be allowed for apprentice teaching in addition to the six hours of electives aforementioned. All military science credits, including those in the basic course, apply toward the student's over-all cumulative average.

Career Opportunities

Individuals are commissioned as officers in the United States Army after completion of the ROTC program, the advanced camp, and their university degree requirements. The majority then qualify for active duty in the Army in brances (specialities) such as the Corps of Engineers, Military Intelligence, Ordnance, Aviation, Finance, Field Artillery, Armor, Infantry, Medical Service Corps, Nursing, or eight other major fields. Officers can work as leaders, specialists, or combinations of the two depending on the assignment.

There are opportunities for advanced military and civilian schooling beginning with nearly three months of effort in the branch specialty. A person can also receive one alternate specialty in such areas as systems analysis, information, foreign area specialization or comptroller. Upon graduation, students have a choice of active duty or reserve forces duty (RFD). The RFD option provides the student with the opportunity to maintain the options of a military or civilian career upon completion of the program. Those individuals who receive the RFD option become officers in the Army Reserve or Army National Guard in their hometown area and essentially have a part-time military career. An officer can earn retirement through both programs after twenty years of service.

Physical facilities. Army ROTC uses areas on and adjacent to the university campus to conduct field training. These locations are excellent for most outdoor activities such as orienteering, patrolling, scuba diving, and survival training. Fort Indiantown Gap Military Reservation, located east of Harrisburg, Pa., is used for some field training exercises and weapons familiarization during one of two annual weekend trips. The other trip is, usually, taken to another active Army installation such as Ft. Belvoir, Virginia, and Aberdeen Proving Ground, Maryland. Other locations in Pennsylvania used for cadet adventure training are: Ralph Stover State Park (mountaineering); Delaware and Lehigh rivers (rafting); and, the university's Saucon Valley athletic complex (cross-country skiing).

Programs and Opportunities

ROTC scholarship program. This program is designed to offer financial assistance to outstanding young men and women entering the ROTC program who are interested in an Army career. Each scholarship provides full tuition, textbooks and laboratory fees, in addition to pay of $100 per month for the period the scholarship is in effect. Three-and two-year scholarships are available to outstanding cadets who are currently enrolled in the four-year ROTC program and are completing either their freshman or sophomore years of college.

Four-year scholarships are open to all students entering ROTC as freshmen. Recipients of an ROTC scholarship are required to complete at least one semester of Indo-European or Asian language prior to commissioning. Applications for scholarship must be made to Headquarters, First ROTC Region, Fort Bragg, N.C. 28307, during the junior or senior year of high school. This may be done as early as the spring semester of the junior year, but not later then December 15 of the senior year.

Two-year program. Students who want to enroll in ROTC after their sophomore year may apply. Applicants must successfully complete a six-week basic summer camp and have two years of undergraduate or graduate studies remaining. The student is paid for the six-week encampment and receives transportation costs to and from the camp. Individuals start in the advanced course after the basic camp.

Distinguished military graduate (DMG) program. This is a competitive program that permits outstanding ROTC students to apply for a Regular Army commission immediately upon graduation. At the end of the junior year and upon completion of the advanced summer camp, approximately one-third of each senior ROTC class may be designated as distinguished military students (DMS). A student who maintains the same high standards throughout the senior year may qualify for designation as a distinguished military graduate (DMG) and may be offered a Regular Army commission upon graduation.

Off-campus U.S. Army Training Schools. Selective cadets are authorized to attend the following U.S. Army Schools: Airborne School (Fort Benning, Georgia), Air Assault School (Fort Campbell, Kentucky), Ranger School (Georgia and Florida), and Northern Warfare School (Fort Greely, Alaska). This off-campus program is fully funded by the U.S. Army.

Minor in military science. A minor in military science is available in the College of Arts and Science. In addition to successful completion of both the basic and advanced military science course work, the student must take the following required courses:

Eco 1	Economics (4)
Gov 1	American Political System (3)
IR 1	World Politics (3)
IR 51	American Foreign Policy Since 1945 (3)
IR 302	War and World Politics (3)
IR 354	Atlantic Community (3)

plus an Indo-European or Asian language one year (six credit hours) above the current level of proficiency but at the second-year proficiency level at a minimum.

Commissioning Requirements

Individuals must either complete the two- or four-year programs, attend the advanced camp, and receive a college degree to become commissioned officers in the U.S. Army.

Course Descriptions

Leadership Laboratory is conducted for all students on Monday afternoons. The Leadership Laboratory provides students the opportunity to demonstrate an understanding of the leadership process to include the ability to: communicate the theoretical terminology necessary to be an effective leader; synthesize the key aspects of the leadership process into a sound model of organizational effectiveness; influence human behavior in the accomplishment of selected goals; and apply academic theory to specific military situations.

Instruction at several levels on a variety of subjects with military application provides the context within which students are furnished opportunities to both teach and lead in a group setting. Responsibility is expanded as the student progresses through the program. In the senior year, the students assume the responsibility for the planning, preparation and conduct of the laboratory.

13. Introduction to Military Science (1) fall
The U.S Army as an institution with emphasis on the Army's history, customs occupational specialities, and distinctive way of life. Highlighted is the role and function of the Reserve Officers Training Corps in providing the underpinning of the Army's mid-level and upper management.

14. Leadership and Management (1) spring
The role of the individual within the military group in an organizational context, and in terms of his/her contribution to group goal accomplishment. Provides the basis in the military setting for understanding: group dynamics; the relationship of individual differences to group performance; the necessity for effective communications; society's influence on military group and individual behavior; and formal organizational constraints on the leadership process.

21. Topographic Analysis and Land Navigation (2) fall
Essential elements of topography and land navigation techniques including use of self-paced audio-visual instruction and standardized testing of individual skills. Emphasis is on practical applications and field exercises both at individual and small group level.

22. Small Unit Leadership (2) spring
A cross-disciplinary approach to the dynamics of leading an effective military team in both planning and execution modes. Includes establishment of obtainable objectives, sequencing of planning, techniques for furnishing guidance and direction to the group, and management of the team's activities toward task accomplishment. A subportion of the course is devoted to practical work in basic first aid and cardio-pulmonary resuscitation.

105. Methods of Instruction (1) fall
Procedures and techniques used in presentation of military subject material. Students build confidence in expository speaking and the use of supporting graphic presentation materials through practical work. Application of effective teaching methods is evaluated through a series of graded in-class oral presentations of increasing length on technical subjects of military application.

106. Advanced Group Leadership (2) spring
Roles and responsibilities of the junior officer as a leader of a functional portion of the combined arms teams. Formulation and development of needed supporting plans from the leader's perspective provides the core around which situational analysis is conducted and resources are allocated toward task fulfillment. A weekend field training exercise is utilized to reinforce learned leadership techniques and enhance individual self-confidence.

Advanced ROTC Summer Camp
This is a six-week training program conducted at Fort Bragg, N.C. Prerequisites are completion of the basic military science courses or their equivalent and MS 105 and 106. Under special circumstances and upon approval of the department chairman, this camp may be delayed until after graduation or completion of the advanced course. The summer camp experience, in coordination with respective engineering curricula, may be used to fulfill the industrial employment requirements of the engineering courses ChE 100, CE 100, EE 100, IE 100, ME 100, and Met 100. Nursing students spend their six-week camp working and training in an Army hospital.

107. The Military Staff (2) fall
Problem-solving and decision-making processes for military staff managers. Concepts covered through practical application, case study, and role playing include: the management cycle, task-organizing, team-building, inter-/intra-organizational communications and organizational/personal power and authority. Additionally, each class member prepares a research paper concerning a problem or issue relevant to the military science program class as a whole.

108. The Army Officer in the Military Community (1) spring
Compares and contrasts the responsibilities and benefits of the commissioned officer as leader and follower, citizen and soldier. Emphasis is on developing the intellectual and behavioral skills necessary to deal effectively with the wide range of "people problems" that the officer can expect to encounter. Course material is designed to assist the student to develop a foundation of personal values and professional ethics that aid in making the transition from the academic to the military/civilian environment.

300. Apprentice Teaching in Military Science (2) fall-spring
Enrollment limited to MS IV students approved by the department chairperson.

Modern Foreign Languages

Professors. David W.P. Lewis, Dr. de l'Univ., *chairperson* (French); Arthur P. Gardner, Ph.D. (German); Anna Pirscenok Herz, Ph.D. (Russian); Victor M. Valenzuela, Ph.D. (Spanish); John A. Van Eerde, Ph.D. (French and Italian).
Associate professors. Linda S. Lefkowitz, Ph.D. (Spanish); Anje C. van der Naald, Ph.D. (Portuguese and Spanish); D. Alexander Waldenrath, Ph.D. (German).
Assistant professors. Therese Decker, Ph.D. (German); Lenora D. Wolfgang, Ph.D. (French).
Lecturers. Wolfgang de Beauclair, M.A. (Chinese);

Julia S. Fang, M. Ed. (Chinese); Harriet L. Parmet, M.Sc. Ed (Hebrew).
(Languages in parentheses indicate languages normally taught.)

Command of foreign languages not only gives the student a deeper insight into his or her native tongue but also opens the door to other cultures, traditions and modes of thought. Knowledge of languages is valuable in a broad range of professions. Linguistic skills are useful tools in journalism, government, international relations, law and increasingly in international business. The specialist may become a translator, interpreter or teacher. A bachelor of arts degree with a major in languages can be a stepping stone to graduate school in other fields such as law, medicine and business. Finally, an ability to read foreign languages is important and often required for research in science and technology. In short, language skills are personally enriching and enhance career prospects.

For its modest size, Lehigh offers an unusually wide range of modern languages including Mandarin Chinese, French, German, Hebrew, Italian, Brazilian Portuguese, Russian and Spanish.

The courses available include writing and speaking, reading and listening, literature, civilization and professional areas such as business and health careers. A number of culture courses are given in English, but most offerings stress classroom use of the language. Facilities include a modern language laboratory, student residences for German, French, and Spanish, and a Russian club.

Language Requirements

The B.A. distribution requirements include a category for either foreign language or culture and literature in translation (see page 37). Requirements for the B.A. and B.S. in chemistry include German (preferred), French or Russian (see page 99) For the B.A. in international relations, students must offer a foreign language or computer science. The College Scholar program in the College of Arts and Science; the minors in Italian studies and Latin American studies; and the minor in military science require language study. Students taking the B.A. in foreign careers are expected to study a language. Some doctoral programs also require foreign language competence, usually assessed by the department of modern foreign languages.

Language placement requirement. Students are expected to take Advanced Placement or College Board Achievement Tests while still in high school. With the assistance of these scores, students are placed in courses at appropriate levels. *The Achievement Test score alone does not guarantee credit at any given level.* To ensure credit, students uncertain as to their proper level of placement should consult with the chairperson of the department. Advanced standing credit towards graduation is awarded for an AP score of 4 or 5 and for an Achievement Test score of 750.

Advising. Because of the sequential nature of language study and the variety of specializations available, the department pays special attention to student advising. Students whose experience, skills and placement scores (Advanced Placement or College Board Achievement Test) do not give them a clear indication of their level of placement should consult with their instructor or the department chairperson. Faculty members responsible for more advanced advising are currently as follows: graduate students, Lewis; French major, Van Eerde; French minor, Wolfgang; German major and minor, Waldenrath; Italian studies, Van Eerde; Jewish Studies, Parmet; Latin American studies, Valenzuela; Russian minor and area studies, Herz; Spanish major, van de Naald, and minor, Lefkowitz. Drs. van der Naald and Wolfgang are the advisers to the French/Spanish House. The German House adviser is Dr. Decker.

Major programs. The department offers major programs in French, German, and Spanish. The candidate for the major is expected to demonstrate adequate written and oral command of the language, as well as knowledge of its literature and culture.

Double majors and Arts/Engineering majors including a language component are increasingly popular and well received by employers. Studies in the two areas are carefully coordinated by major advisers.

Minor programs. The department offers minor programs in French, German, Russian and Spanish, and coordinates these studies with a student's major requirements in any college.

Related programs. These are available in East Asian studies, Foreign Careers, Italian Studies, Jewish Studies, Latin American Studies and Russian Studies.

Language of instruction. All courses are taught in the target language aspect where otherwise indicated. Students are thereby rapidly accustomed to considering the language as an active means of communication and not solely as an object of study.

Courses in English. The department offers elective courses in English on literary, cultural and social subjects. These courses have no prerequisite and may, in most cases, be taken to fulfill preliminary distribution requirements. In some cases, they are offered in conjunction with other departments. One of these courses may be included in the major.

Study abroad. The department encourages students of foreign languages to spend a summer, a semester, or a full year on an approved program of study abroad. The department offers a limited number of travel scholarships for foreign study to qualified students. Applications should be submitted by November 1 for the spring semester and by March 1 for summer or fall. For credit, transfer students must consult in advance with appropriate departments, Dean Ellis, the registrar and when appropriate the office of financial aid.

Lehigh offers two summer programs through the Lehigh Valley Association of Independent Colleges (LVAIC). Language students, especially those majoring or minoring in a foreign language or in a program of international study, are encouraged to spend a summer or semester abroad in a "living laboratory." The two programs are available in Poitiers, France, and Madrid, Spain. A faculty member, acting as program director, accompanies the students. Courses are taught at elementary, intermediate and advanced levels, by qualified instructors from host institutions.

Credits and grades are fully transferable under normal LVAIC cross-registration procedures. Interested students should consult with the department of modern foreign languages, Coppee Hall.

Campus foreign language houses. The foreign language residences for French, German and Spanish are recognized, together with the International House, as an important feature of campus life. Students are encouraged to consider living there.

Foreign Culture and Literature Taught in English

These courses on foreign cultures and comparative topics carry no prerequisites; knowledge of the foreign language is not required.

Language majors may take one course taught in English by the department for credit toward a major requirement. Interested students should consult their language major advisers.

MFL 21. Russian Literature and Culture I (3)
Customs, institutions and literary contributions to western civilization. Herz

MFL 22. Russian Literature and Culture II (3)
Continuation of MFL 21. Herz

MFL 31. Masterpieces of French Literature (3)
Main genres in French literature, Arthurian romance, essay, poetry, theater, novel and short story. Readings and discussion. Van Eerde

MFL 33. The French-Speaking World Today (3)
Modern France and the French-speaking world: culture values, problems: and modes of thought from Paris to Marseilles, from Quebec to Senegal. Lewis

MFL 34. Voltaire and the Encyclopedia (3)
Voltaire's contributions to various genres during the Enlightenment and issues treated in the Great Encyclopedia. Van Eerde

MFL 41. The German Lied (3)
The intimate relationship between the music and the text of the German art-song. Gardner

MFL 42. The German Musical Theatre (3)
The German opera tradition from Gluck and Mozart to Henze. Gardner

MFL 43. German Literature in Translation (3)
One period or theme in German literature. Waldenrath

MFL 44. Pennsylvania German Culture (3)
Cultural contribution of Pennsylvania Germans: their history, literature, art, music and politics. Waldenrath

MFL 51. Contemporary Hispanic-American Literature (3)
Reading and discussion of distinguished Latin American writers: Borges, Garcia Marquez, Cortazar and Vargas Llosa. Valenzuela

MFL 53. The Hispanic World and Its Cutlure (3)
Characteristics and values of the people of Spain and Latin America in literary works and other material. Hispanic cultural contributions to Western civilization. Valenzuela

MFL 61. Cultural Mozaic of Modern Israel (3) annually
Cultural and religious components of the State of Israel: creative and performing arts and sociological patterns such as population, immigration, ethnic diversity, and emerging literature. Parmet

MFL 71. Introduction to Chinese Culture (3) spring
Traditional Chinese attitudes and other concepts.
de Beauclair

MFL 81. Brazil and its Culture (3)
Cultural development in Brazil, from colonial times to the present. van der Naald

MFL 321. Russian Realism (3)
Russian realists of the 19th century; Dostoevsky, Turgenev, Tolstoy, *et al.* Lectures and class discussion in English; collateral reading and written reports in Russian or English. Herz

MFL 322. Contemporary Soviet Literature (3)
Socialist realism in Russian literature since 1917. Lectures and class discussion in English, collateral reading and written reports in Russian or English.

Chinese

The department offers the following courses in Mandarin Chinese. A course in Chinese culture taught in English is listed above, MFL 71. For East Asian studies see page 38.

1. Elementary Chinese I (4)
Spoken and written Mandarin Chinese, the standard romanized transcription system used in the People's Republic, Chinese characters. Basic speech patterns, vocabulary, and pronunciation. One weekly laboratory hour. de Beauclair, Fang

2. Elementary Chinese II (4)
Continuation of Chinese I; more advanced vocabulary and sentence structures. One weekly laboratory hour. Prerequisite: Chinese I or equivalent. de Beauclair, Fang

11. Intermediate Chinese I (3)
More advanced character texts. Folklore, brief readings in Chinese and articles in the vernacular. de Beauclair

12. Intermediate Chinese II (3)
Continuation of Intermediate Chinese II; more formal oral and written exercises in the vernacular. Prerequisite: Chinese II or equivalent. Fang

French

The following courses involve use of the French language.

Preliminary courses. These may be replaced by advanced standing for students who qualify.

French 1	Elementary French (4)
French 2	Elementary French (4)
French 11	Intermediate French (3)
French 12	Intermediate French (3)

Requirements for the major. A minimum of twenty-seven credit hours is required beyond French 12, as follows:
French 43 and 44, Advanced Oral and Written French (6)
French 51 and 52, Survey of Literature (6)
Two or three courses from the following: French 59, 245, 247, MFL 31, 33, 34 (6-9). (Only one course taught in English may be included.)
Two or three courses at the 300 level. (6-9)

Requirements for the departmental honors major. Thirty-three credit hours are needed. Requirements are the same as for the major, plus six additional hours of advanced literature and a 3.50 average in the major.

Recommended related courses. Students majoring in French are urged to take courses on related subject, either within or outside the department, as approved by their adviser.

Requirements for the minor. Fifteen credit hours are required above French 12 as follows:
French 43 (3)
Two or three of 44, 46, 51, 52, 59, 245, 247 (6-9)
One or two courses at 200 or 300 level. (3-6)

Requirements for advanced courses. Except where otherwise noted, 200 or 300-level courses are open to students having completed six credit hours of French beyond French 12. Exceptions require the consent of chairperson.

Language of instruction. Courses are normally conducted in French. Courses in French culture taught in English are listed under Foreign Culture above, MFL 31, 33, 34.

Undergraduate Courses in French

1. Elementary French I (4) fall and spring
Basic conversational French, illustrating essential grammatical principles, reading simple texts and writing. Language laboratory practice.

2. Elementary French II (4) fall and spring
Continuation of French I. Prerequisite: French 1 or appropriate Achievement Test score before entrance, or consent of the chairperson.

11. Intermediate French I (3) fall and spring
Complete grammar review. Readings and discussion. Prerequisite: French 2 or appropriate Achievement Test score before entrance, or consent of chairperson.

12. Intermediate French II (3) fall and spring
Emphasis on readings and discussion. Prerequisite:

French 11, or appropriate Achievement Test score before entrance, or consent of chairperson.

41. French Pronunciation (1)
Correct pronunciation of French: the obstacles commonly encountered by American speakers. Articulation, rhythm and pitch. Introduction to the International Phonetic Alphabet. Laboratory work. Prerequisite: any French course previously or concurrently.

43. Advanced Oral and Written French I (3) fall
Intensive practice in oral and written French. Prerequisite: French 12, or Achievement Test score of 570 or consent of chairperson.

44. Advanced Oral and Written French II (3) spring
Continuation of French 43. Prerequisite: French 43 or consent of chairperson.

46. Intermediate French for Business and Foreign Careers (3) spring, alternate years
For students who want "vocational" French but are uncertain of their readiness for highly specialized material. Intensive revision of grammer, reading of simple contemporary texts, conversation, composition and letter writing. Prerequisite: French 11 or consent of the chairperson. Lewis

51. Survey of French Literature I (3) fall 1984, 1985
From the Middle Ages through the 18th century. Prerequisite: French 12 or consent of the chairperson. Van Eerde

52. Survey of French Literature II (3) spring 1985, 1986
Representative works of the 19th and 20th centuries. Prerequisite: French 51 or consent of the chairperson. Van Eerde

59. The French-Speaking World and Its Culture (3)
Cultural, social and artistic development of France and the French-speaking world. Lewis

81. French Cultural Program (1-6)
A summer program abroad. Formal instruction in the French language and direct contact with the people and their culture during one or two months in a French-speaking country.

For Advanced Undergraduates And Graduate Students

221. *L'Evasion:* Fantasy and Escapism in French Literature (3)
Psychological and artistic study of the writer's eternal search for the ideal world. Prerequisite: Any of French 43, 44, 51, 52, 59. Lewis

223. Love in the French Novel (3)
Representative works from each period of French literature from *Tristan et Iseut* and *La Princess de Cleves* to Gide's *L'Immoraliste.* Style, themes, myths and story patterns are analyzed. Prerequisite: any of French 43, 44, 51, 52, 59. Wolfgang

245. Advanced French for Business and Foreign Careers (3) spring, alternate years
Understanding and writing French for business and international affairs, grammar reviews as necessary. Readings and oral presentations of current interest, with technical vocabulary (marketing, finance, industry, communications, transport, law, energy, economic relations, environment, etc.). Conducted in French. Prerequisite: Any of French 43, 44, 46 or consent of chairperson. Lewis

247. Writing and Stylistics (3)
Practice in writing by studying the style of French authors. *Explications de texte.* Prerequisite: French 44 or 245. Lewis

269. French-Canadian Literature (3)
Literary trends and leading authors of French Canada, from 18th century to the present. Prerequisite: Any of French 43, 44, 51, 52, 59. Lewis

270. Black Literature (3)
Major authors of French-speaking Africa and the Caribbean. Conducted in French. Prerequisite: Any of French 43, 44, 51, 52, 59. Lewis

271. Readings (3)
Study of the works of some author or group of authors, of a period, or of a literary theme. May be repeated once for credit. Prerequisite: French 12 or consent of the chairperson.

281. French Cultural Program (1-6)
A program in a French-speaking country offering formal language courses and cultural opportunities. Prerequisite: consent of the chairperson.

301. Advanced Composition and Translation (3)
Techniques of translation. Literary, political, and technical texts. Essay-writing techniques and free composition. Prerequisite: a 200-level course or consent of the chairperson.

303. Renaissance Poetry (3)
Study of the major poets of the period. Conducted in French. Wolfgang

305. Prose in the 16th Century (3)
Analysis of fiction, memoirs, historical documents, including the works of Rabelais, Montaigne, Marguerite de Navarre, Bonaventure de Periers, Jean Calvin. Wolfgang

308. Symbolism (3)
Intensive study of the symbolist school of poetry, following Baudelaire through Mallarmé and the end of the 19th century. Lewis

309. Medieval French Literature (3)
Introduction to Old French from *La Chanson de Roland* to Francois Villon. Wolfgang

311. French Classicism (3)
French classical theater, novel and criticism, with emphasis on Corneille, Racine, Moèlire, Madame de Lafayette, Malherbe and Boileau. Van Eerde

312. French Classicism (3)
Continuation of French 311. Prerequisite: French 311 or consent of the chairperson. Van Eerde

313. The Age of Enlightenment (3)
The *Philosophes* and *Encyclopédistes* of the 18th century, with emphasis on Voltaire, Rousseau, Montesquieu and Diderot. Van Eerde

314. The Age of Enlightenment (3)
Continuation of French 313. Conducted in French. Prerequisite: French 313, or consent of chairperson. Van Eerde

317. The Romantic Movement (3)
The Romantic movement in France with readings from its principal exponents. Lewis

318. Drama in the Twentieth Century (3)
Contemporary French drama with an analysis of its origins and movements. Lewis

323. From the Romantic Novel to the Present (3)
Representative authors, such as Stendhal, Balzac,

Flaubert, Proust, Gide, Malraux, Sartre, Camus, Robbe-Grillet. Lewis

331. French Poets of the Twentieth Century (3)
Leading poets from Paul Valéry to Anne Hébert. Lewis

333. Great Women Writers of France (3)
Women writers of France from the Middle Ages to the present. Van Eerde.

371. Independent Study (1-4)
Special topics under faculty guidance. May be repeated once for credit. Prerequisite: consent of the chairperson.

German

Preliminary course. These may be replaced by other courses when a student qualifies for advanced standing.

German 1	Elementary German (4)
German 2	Elementary German (4)
German 11	Intermediate German (3)
German 12	Intermediate German (3)

Requirements for the major. A minimum of twenty-seven credits beyond German 12 as follows:

German 63	Introduction to German Culture (3)
German 65	Introduction to the German Literary Tradition (3)
German 67	Conversation and Composition (3)
German 201	Survey of German Literature I (3)
German 241	Advanced Conversation and Composition (3)

Four additional courses above the German 12 level, three of which must be taken as follows: German 344 or German 303, German 325 or 326, and German 305 or 306.

Requirements for the departmental honors major. Requirements are the same as for the major, plus: two additional advanced literature courses at the 300 level; dissertation or comprehensive examination (written or oral); an average of 3.50 in courses in the major.

Recommended related courses. Students majoring in German are urged to take courses on related subjects, either within or outside the department, as approved by their adviser.

Requirements for the minor. Fifteen credits above German 12 are required as follows: German 63 or 65; German 67; three additional courses, including at least one at 300-level.

Requirements for advanced courses. The prerequisite for all 200-level courses is at least one three-credit course taught in German beyond German 12 or equivalent. The prerequisite for all 300-level courses is at least two three-credit courses beyond German 12 (course in English excluded) or equivalent. Prerequisite may be waived by consent of the chairperson.

Language of instruction. Courses are normally conducted in German. Courses in German culture conducted in English are listed under Foreign Culture above, MFL 41, 42, 43 and 44.

Undergraduate Courses in German

1. Elementary German I (4) fall and spring
Fundamentals of German; reading of simple texts; simple conversation and composition; vocabulary building. Three class hours plus one laboratory or drill hour each week. No previous German required.

2. Elementary German II (4) fall and spring
Continuation of German 1, including reading of more advanced texts. Three class hours plus one laboratory or drill hour each week. Prerequisite: German 1, or two units of entrance German, or consent of the chairperson.

11. Intermediate German I (3) fall and spring
Review of grammar, composition, reading of intermediate texts, vocabulary building. Prerequisite: German 2 or four units of entrance German, or consent of the chairperson.

12. Intermediate German II (3) fall and spring
Continuation of German 11. Prerequisite: German 11 or consent of chairperson.

21. German House (1) fall and spring
Supervised participation in German House activities. Pass/fail only. Grade given for participation in a prescribed minimum number of activities, upon recommendation of the faculty adviser. May be repeated for credit, but not more than three such hours may be applied toward a major in German. Students should contact course instructor immediately upon registering. Decker

63. Introduction to German Culture (3) annually
Lectures, readings and discussion of selected aspects of German culture. Prerequisite: German 12 or equivalent, or consent of chairperson.

65. Introduction to the German Literary Tradition (3) annually
Representative works from one or more of the major periods of German literature. Prerequisite: German 12 or equivalent, or consent of chairperson.

67. Conversation and Composition (3) annually
Intensive practice in oral and written German. Prerequisite: German 12 or equivalent, or consent of chairperson.

For Advanced Undergraduates And Graduate Students

201. Survey of German Literature I (3) fall
German literature to the second half of the 18th century. Readings, lectures and discussion of representative works.

202. Survey of German Literature II (3) spring
From the Age of Goethe to the present. Readings, lectures and discussion of representative works.

211. Introduction to German Drama (3)
Drama as a literary genre; plays from various periods of German Literature. Gardner

213. Introduction to the German Lyric (3)
The lyric as a literary genre; representative poets from various periods. Gardner

214. Goethe's "Faust" (3)
Study of Goethe's play with an introduction to the Faust tradition.

241. Advanced Composition and Conversation (3)
Conducted in German.

250. Special Topics (1-3)
Literary and linguistic topics not covered in regular courses. May be repeated once for credit.

281. German Cultural Program (1-6)
Study abroad. Formal instruction in German and direct contact with the people and their culture during at least one month in a German-speaking country. Prerequisite: German 63, 65, or 67, and consent of the chairperson.

301. Middle High German Literature (3)
Lectures and readings in medieval literature. Introduction to Middle High German. Decker

303. German Romanticism (3)
Early and late Romanticists. Waldenrath

305. 20th-Century German Literature I (3) fall
Representative writers from Naturalism to Expressionism. Gardner

306. 20th Century German Literature II (3) spring
Representative writers from Expressionism to the present. Gardner

307. German Renaissance, Baroque and Enlightenment (3)
Writers and literary movements from the end of the Middle Ages to the middle of the 18th century. Decker

325. 19th-Century German Literature I (3)
Representative writers from Eichendorff to the Biedermeier. Gardner

326. 19th-Century German Literature II (3)
Representative writers from the Biedermeier to Naturalism. Gardner

341. Advanced Composition (3)
Essay writing and translation from and into German.

344. The Age of Goethe (3)
Selected works from Klopstock to Holderlin, with special emphasis on Herder, Goethe and Schiller. Waldenrath

350. Special Topics (1-3)
Literary or linguistic topics not covered in regular courses. May be repeated once for credit. Prerequisite: permission of the chairperson.

Hebrew

The department offers courses both separately and in the context of the Jewish Studies minor (see page 39)

Language of instruction. Courses are normally conducted in Hebrew. A course in Hebrew culture taught in English is listed under Foreign Culture above, MFL 61.

1. Elementary Modern Hebrew I (3) fall
Classroom and laboratory instruction geared to the development of hearing, speaking, reading and writing the language. Cultural, ethnic and religious dimensions of Israeli society. Tapes, textural materials, short stories. No previous study of Hebrew required. Parmet

2. Elementary Modern Hebrew II (3) spring
Continuation of Hebrew 1 utilizing the audio-lingual approach. Fundamentals of the language, structure and sounds; the Hebrew verb; reading and vocalized stories; written exercises; tapes; short stories. Prerequisite: Hebrew I or its equivalent. Parmet

11. Intermediate Modern Hebrew I (3) fall
Classroom and laboratory instruction to develop fundamental patterns of conversation and grammar; composition, reading of texts, laboratory work and sight reading; comprehension, speaking, reading and writing of unvocalized materials. Prerequisite: Hebrew 2 or qualifying examination. Parmet

12. Intermediate Modern Hebrew II (3) spring
Continuation of Hebrew 11. Reading of texts, including selected short stories, outside reading and supplementary material; increased emphasis on oral presentation. Prerequisite: Hebrew 11 or approval of the department chairperson. Parmet

Italian

The department offers courses in Italian both separately and in the context of the minor in Italian Studies (see page 39 for which Italian language is required.

Language of instruction. Courses are normally conducted in Italian.

1. Elementary Italian I (3) fall, alternate years
Grammar, composition, rapid reading of easy modern prose. No previous study of Italian required. Van Eerde

2. Elementary Italian II (3) spring, alternate years
Continuation of Italian 1. Prerequisite: Italian 1 or equivalent or consent of chairperson. Van Eerde

11. Intermediate Italian I (3) fall, alternate years
Review of grammar by reading literature. Development of speaking, with some attention to writing in compositions pertaining to daily experience. Prerequisite: Italian 2. Van Eerde

12. Intermediate Italian II (3) spring, alternate years
Continuation of Intermediate Italian I. Prerequisite: Italian II or consent of chairperson. Van Eerde

171. Advanced Readings (3)
Intensive independent study of literary topics. May be repeated once for credit. Prerequisite: Italian 12 or consent of chairperson. Van Eerde

Portuguese

Language of instruction. Courses are conducted in Brazilian Portuguese. A course in Brazilian culture taught in English is listed above, MFL 81.

1. Elementary Portuguese I (3) fall, alternate years
Basic conversational Brazilian Portuguese; principles of grammar and syntax. van der Naald

2. Elementary Portuguese II (3) spring, alternate years
Continuation of Portuguese I. Prerequisite: Portuguese I or consent of chairperson. van der Naald

11. Intermediate Portuguese I (3) fall, alternate years
Conclusion of grammar presentation. Contemporary readings. Practice in speaking and writing. Prerequisite: Portuguese 2 or consent of the chairperson. van der Naald

12. Intermediate Portuguese II (3) spring, alternate years
Grammar review. Readings of Brazilian authors. Emphasis on oral and written fluency. Prerequisite: Portuguese II or consent of the chairperson. van der Naald

Russian

Requirements for minor. Eighteen credit hours of Russian are required not including MFL 21, 22, 321 or 322. For Russian studies minor, see page 40.

Language of instruction. Courses are normally conducted in Russian. Courses in Russian culture taught in English are listed under Foreign Culture above, MFL 321 and 322.

1. Elementary Russian I (3) fall
Classroom and laboratory introduction to the fundamentals of conversational and grammatical patterns; practice in pronunciation, simple conversation, reading and writing. Herz

2. Elementary Russian II (3) spring
Continuation of Russian 1. Prerequisite: Russian 1 or two units of entrance Russian. Herz

11. Intermediate Russian I (3) fall
Classroom and laboratory practice in conversation. Development of reading and writing skills. Prerequisite: Russian 2 or three units of entrance Russian, or consent of chairperson. Herz

12. Intermediate Russian II (3) spring
Continuation of Russian 11. Prerequisite: Russian 2 or 11, or three units of entrance Russian, or consent of chairperson. Herz

31. Russian in Science, Economics, and Industry I (3) fall
Readings and conversations about nonliterary topics including the social and natural sciences, business, economics and industry. Prerequisite: Russian 12 or consent of chairperson. Herz

32. Russian in Science, Economics, and Industry II (3) spring
Continuation of Russian 31. Prerequisite: Russian 12 or 31, or consent of chairperson. Herz

41. Conversation and Composition I (3) fall
Intensive practice in oral and written Russian; laboratory practice in aural comprehension. Readings and discussions on Russian literature and culture. Prerequisite: Russian 12, or three units of entrance Russian, or consent of chairperson. Herz

42. Conversation and Composition II (3) spring
Continuation of Russian 41. Prerequisite: Russian 41 or consent of chairperson. Herz

251. Special Topics (3)
Intensive study of literary or linguistic topics. Prerequisite: Russian 42, or consent of chairperson. May be repeated for credit. Herz

391. Special Topics (1-3)
Independent study or research under faculty guidance on a literary, linguistic, or methodological topic. May be repeated once for credit. May be used to satisfy the doctoral language requirement. Prerequisite: undergraduate degree and consent of chairperson. Herz

Spanish

Preliminary courses. These may be replaced by other courses if students achieve advanced standing.

Span 1	Elementary Spanish (3)
Span 2	Elementary Spanish (3)
Span 11	Intermediate Spanish (3)
Span 12	Intermediate Spanish (3)

Requirements for the major. A total of twenty-seven credit hours are required above Span 12 as follows: Span 141, 142 or 255, 151, 152.
Five courses at the 300-level: at least two must be selected from Peninsular literature and at least two from Latin American literature.

Students may replace Spanish 151 or 152 by MFL 53; or a course in modern Hispanic American literature by MFL 51. Not more than one course taught in English may be included in the major.

Requirements for departmental honors major. Thirty-three credit hours are required above Span 12 as follows: twenty-seven credits, as for the major; six additional hours of advanced courses; a 3.50 average in the major.

Requirements for the minor. Fifteen credits are required above Span 12, including Span 141; one course in literature; and one of the following: 142 or 255.

Recommended related courses. Students majoring in Spanish are urged to take courses on related subjects inside or outside the department, as approved by their adviser.

Requirements for advanced courses. The normal prerequisite for 200- and 300-level literature courses in Spanish is Span 151 and/or 152. Exceptions require consent of chairperson.

Language of instruction. Courses are normally conducted in Spanish. A course in Spanish culture taught in English is listed under Foreign Culture above, MFL 153.

Undergraduate Courses in Spanish

1. Elementary Spanish (3) fall and spring
Basic conversational Spanish illustrating essential grammatical principles. Reading of simple texts and writing. Students will be required to practice each lesson in the language laboratory.

2. Elementary Spanish II (3) fall and spring
Continuation of Span I. Prerequisite: Span 1 or equivalent.

11. Intermediate Spanish I (3) fall and spring
Conclusion of grammar presentation. Contemporary readings. Practice of speaking and writing. Prerequisite: Spanish 2.

12. Intermediate Spanish II (3) fall and spring
Grammar review. Readings of Spanish and Latin American authors. Emphasis on acquiring oral and written fluency. Prerequisite: Spanish 11.

131. Communicating in Spanish for Medical Personnel (1)
For prospective medical personnel communicating with Spanish-speaking patients. Dialogues, health-care vocabulary. Review of grammar. Language laboratory practice. Prerequisite: one year of college or three years of high school Spanish. Lefkowitz

133. Phonetics and Pronunciation (1)
Comparison of Spanish and English sounds; descriptions of Spanish vowels and consonants in their various positions. Abundant oral practice and special emphasis on accent and intonation patterns. Exercises in phonetic transcription, employing the international phonetic alphabet. Prerequisite: Span 12. Lefkowitz

141. Advanced Grammar and Composition (3) fall
Intensive review of Spanish grammar with stress on finer points. Analysis of syntax and style. Prerequisite: Span 12.

142. Advanced Conversational Spanish (3) spring
Conversational practice stressing the building of vocabulary, based on literary texts and topics of general interest. Designed to stimulate fluent and spontaneous use of spoken Spanish. Prerequisite: Span 141 or consent of chairperson.

151. Cultural Evolution of Spain (3) fall
The historical and cultural evolution of Spain from its beginning to the present. Prerequisite: Span 12 or consent of chairperson. Lefkowitz or van der Naald

152. Cultural Evolution of Latin America (3) spring
The historical and cultural evolution of Latin America. Prerequisite: Spanish 151 or consent of chairperson. Valenzuela

162. Women Writers of Latin America (3) spring
The contribution of women writers to Latin American literature. Prerequisite: Spanish 152. Valenzuela

For Advanced Undergraduates And Graduate Students

211. Practical Business Spanish (3)
For students with a basic knowledge of Spanish: the language in business, law, international and social relations. Letter-writing, comprehension of technical texts, specialized professional vocabulary and review of grammar. Prerequisite: Span 12 or equivalent. Lefkowitz

212. Writing Skills (3)
Improving writing proficiency through practice in composition and translation. Prerequisite: Spanish 141 or equivalent. Lefkowitz

231. Spanish American Literature (3)
Literature of the pre-Columbian, conquest and colonial periods. Oral and written reports. Prerequisite: Spanish 152. Valenzuela

255. Improvisational Theater Games in Spanish
For students who have some fluency in the language and who wish to practice and improve their oral Spanish in a creative setting. Enrollment limited to 15. Prerequisite: Spanish 141 or consent of chairperson. van der Naald

263. The Latin American Short Story (3)
Reading and discussion of outstanding Latin American short story writers. Prerequisite: Span 152. Valenzuela

271. Independent Study (3)
Study of an author or group of authors or of a period. Prerequisite: consent of the chairperson. May be repeated once for credit.

281. Spanish Cultural Program (1-6)
A program abroad. Formal instruction in Spanish grammar, conversation and culture during one or more months in Spain or Latin America on an approved program.

301. The Spanish Essay (3)
Reading and discussion of outstanding thinkers from the 18th century to the present. Prerequisite: Span 151 or consent of the department chairperson. van der Naald

302. The Latin American Essay (3)
Reading and discussion of distinguished Hispanic American essayists of the 20th Century with emphasis on the work of Rodo, Vasconcelos Van Ferreira and Francisco Romero. Oral and written reports. Prerequisite: Spanish 152. Valenzuela

303. Don Quijote (3)
Reading and critical analysis. Prerequisite: Span 151. Lefkowitz

305. Spanish Literature of the Middle Ages (3)
Reading and discussion of outstanding works such as *El Cid, El Libro de Buen Amor* and *La Celestina.* Topics vary. Prerequisite: Span 151. Lefkowitz

306. Existentialism and the Latin American Novel (3)
Reading and discussion of representative works of contemporary Hispanic American novelists. Prerequisite: Span 152. Valenzuela

308. Peninsular Literature Since 1939 (3)
Reading and discussion of representative contemporary Spanish poets, playwrights and novelists. Prerequisite: Span 151 or consent of the department chairperson. van der Naald

310. Literature of 19th-Century Spain (3)
Poetry, novels and plays that exemplify the literary movements of Romanticism, Realism and Naturalism. Topics vary. Prerequisite: Span 151 or consent of department chairperson. van der Naald

315. Nineteenth-Century Spanish Theater (3)
Prerequisite: Span 151, or consent of department chairperson. van der Naald

317. Twentieth-Century Spanish Theater (3)
Prerequisite: Span 151 or consent of department chairperson. van der Naald

319. Spanish Drama of the 17th Century (3)
The development of the Spanish drama of the Golden Age. Prerequisite: Span 151 or consent of department chairperson. van der Naald

333. The Novel of the Mexican Revolution (3)
Reading and discussion of representative novels. Prerequisite: Span 152. Valenzuela

334. Drama in Latin American Literature (3)
Reading and discussion of representative Hispanic American plays of the 19th and 20th centuries. Prerequisite: Spanish 152. Valenzuela

350. Special Topics (1-3)
Study of literary and linguistic topics not covered in regular courses. May be repeated once for credit. Prerequisite: consent of the chairperson.

351. Fifteenth-Seventeenth Century Peninsular Literature (3)
Historical, cultural and literary analysis of prose and poetry. Topics vary. Prerequisite: Span 151. Lefkowitz

353. Development of the Novel in Spain (3)
Caballeresque, Picaresque, Sentimental, Moorish and Pastoral novels from the 14th to the 17th century. Topics vary. Prerequisite: Span 151. Lefkowitz

357. Women Novelists and Playwrights of Latin America (3)
Reading and discussion of outstanding contemporary works by Hispanic American women. Prerequisite: Spanish 152. Valenzuela

361. Gaucho Literature (3)
Reading and discussion of representative works such as *Facundo, Martin Fierro* and *Don Segundo Sombra.* Prerequisite: Span 152. Valenzuela

391. Special Topics (1-3)
Independent study or research under faculty guidance on a literary, linguistic, or methodological topic. May be repeated once for credit. May be used to satisfy the doctoral language requirement. Prerequisite: Undergraduate degree and consent of the chairperson.

Music

Professor. Jerry T. Bidlack, M.F.A., *chairperson.*
Assistant professor. Paul Salerni, Ph.D., Steven Sametz, D.M.A.
Instructor. Nadine J. Sine, M.M.
Adjunct professor. Nancy S. Bidlack, M.M.
Marching Band director. Clark J. Hamman, B.S.

Instrumental instructors. Elaine Martin, flute; Scott Knipe, oboe; Allison Herz, clarinet; Jeffrey Winter, bassoon; Daniel Braden, horn; Lawrence Wright, trumpet; James Brown, trombone; Clark Hamman, tuba; Earl Blackburn, percussion; Rebecca Brown, violin, viola; Nancy Bidlack, violoncello; Dominic Fiore, string bass; Helen Beedle, piano; Sandra Shuler, piano; Bruce Ronkin, saxophone; Richard Metzger, guitar; Freda Herseth, voice; Paul Rowe, voice.

Located in Lamberton Hall, the music department offers courses in music history, literature, theory, and composition, in addition to providing a wide range of performance experience in instrumental and vocal ensembles, and private instruction. Lamberton houses a listening library, practice rooms, a small collection of instruments, an electronic studio, a computer assisted ear-training facility, and a large concert and rehearsal room.

A student graduating with the music major will have gained a strong foundation in the basics of music theory and substantial exposure to the style and repertoire of Western music from the Middle Ages to the present. This curriculum will prepare a student to continue graduate studies in musicology, music theory, or composition. A music major taken in conjunction with a business major may lead to a variety of careers in arts management or in the recording and music publishing industries. Some students may find that a double major or a minor in music will provide the basis for a life-long involvement with an art form which does not necessarily generate income, but gives lasting enjoyment.

Major program. Students majoring in music must take 24 credit hours (beyond Music 20 and 81), which include four courses in music theory and four in music history. Where possible, theory and history courses should be taken in sequence and concurrently. If the schedule does not permit this, history courses may be taken in any order, and any theory courses may be taken after completion of Theory 111. The department encourages majors to elect courses beyond those required from among the additional course offerings and performing opportunities.

Minor programs. Five three-credit courses are required for the minor, and may include Music 20 and 81. Providing they meet the prerequisites, students may take any five courses from the department offerings. A minor must take at least one course from among the theory offerings (Music 81, 111, etc.) and at least one from the music literature courses (Music 20, 131, 132, etc.).

Private lessons. A wide variety of instruments and voice lessons may be taken for one credit. They must be arranged through the department at set fees that are *not* included in tuition.

Performing groups. Admission to band, choir, ensembles, and orchestra is by audition, and students receive one credit per semester by registering for the appropriate course number. Although there is no limit to the number of courses in this series that may be taken, a student should check with the advisors to determine the number that may be applied toward graduation (e.g. only eight credits are applicable in the College of Arts and Science). Performing credits do not count toward the major or humanities distribution requirements.

Music at Lehigh. The department sponsors *Music at Lehigh,* a professional concert series of about ten performances a year open to students and public without charge. Recent appearances include the Orpheus Chamber Orchestra; Calliope, A Renaissance Band; and the Performer's Committee for Twentieth-Century Music. The Ralph N. Van Arnam Chamber Music Series, inaugurated in 1980, presents several concerts each year.

Course Offerings

20. Introduction to Musical Literature (3) fall-spring
Musical style approached through works from the Middle Ages to the present studied in historical and social settings. Emphasis on listening techniques and aquaintance with the masterpieces of Western music. Sine

21-78. Applied music and performance courses may be repeated for credit up to eight times. Prerequisite: consent of the chairperson or audition by faculty member responsible for the course.

21. Marching Band (1) fall
22. Concert Band (1) spring
31. University Choir (1) fall-spring
41. String Ensemble (1) fall-spring
42. Woodwind Ensemble (1) fall-spring
43. Brass Ensemble (1) fall-spring
44. Baroque Ensemble (1) fall-spring
45. Renaissance Ensemble (1) fall-spring
46. Ensemble with Piano (1) fall-spring
47. Vocal Ensemble (1) fall-spring
48. Mixed Ensemble (1) fall-spring
61. String Orchestra (1) fall-spring
71. Private Piano Study (1) fall-spring
72. Private Vocal Study (1) fall-spring
73. Private String Study (1) fall-spring
74. Private Woodwind Study (1) fall-spring
75. Private Brass Study (1) fall-spring
76. Private Percussion Study (1) fall-spring
77. Private Organ Study (1) fall-spring
78. Other Private Study (1) fall-spring

81. Fundamentals of Music Theory (3) fall-spring
Introduction to rhythm, pitch and timbre; melody, counterpoint and harmony; analysis, composition, ear training, keyboard harmony, and sight singing. Prerequisite: consent of the department chairperson. Bidlack

111. Theory I: Principles of Harmonic Analysis (3) fall-spring
Exercises in counterpoint and harmony. Ear training, keyboard harmony, sight singing, and analysis. Prerequisite: Mus 81 or equivalent. Sametz

113. Theory II: Baroque Harmony and Counterpoint (3) fall odd-numbered years
Ear training, keyboard and written harmony and counterpoint, and analysis. Prerequisite: Mus 111. Salerni

131. Major Genres (3) fall or spring
Evolution of a single kind of musical composition. Title varies: Opera, Symphony, etc. May be repeated for credit as title varies. Prerequisite: Mus 20, or 81, or consent of the department chairperson.

132. Composer and Era (3) fall or spring
Life and development of a composer's style viewed in historical context. Title varies: Bach, Beethoven, Mozart, etc. May be repeated for credit as title varies. Prerequisite: Mus 20, or 81, or consent of the department chairperson. Sine

133. History: Medieval and Renaissance Music (3) fall, odd-numbered years
Development of musical style from early Christian chant to the sacred and secular forms of the late sixteenth century, viewed in cultural contexts. Prerequisite: Mus 20 or 81. Sine

134. History: Baroque and Classical Music (3) spring, even-numbered years
The major genres and composers of the 17th and 18th centuries studied in their cultural context. Prerequisite: Mus 20 or 81. Sine

137. History: Romantic Era (19th century) (3) fall, even-numbered years
Study of the major composers and their works from late Beethoven to Mahler and Debussy. Prerequisite: Mus 20 or 81. Sine

138. History: Twentieth-Century Music (3) spring, odd-numbered years
Beginning with the major trends at the turn of the century, a study of the important composers and works of our century to the present. Prerequisite: Mus 20 or 81.

153. Electronic Music (3) fall
Components of an electronic studio introduced via a working relationship. Recording both live and electronic sounds, realizing a portion of score for electronic sound, constructing tape loops having particular characteristics, and preparing a final work of taped sounds. Prerequisite: consent of the department chairperson. Salerni

154. Electronic Music (3) spring
Continuation of Mus 153. Prerequisites: Mus 153 or equivalent and consent of the department chairperson. Salerni

212. Theory III: Classical Forms (3) spring, even-numbered years
Development of musical form in the Baroque, Classical and early Romantic periods. Prerequisite: Mus 111. Sametz

213. Theory IV: Nineteenth-Century Harmonic Practice (3) fall, even-numbered years
Advanced harmonic and contrapuntal techniques applied to the Romantic period. Ear training, keyboard harmony, sight-singing and analysis. Prerequisite: Mus 111. Sametz

220. Composition (3) spring
Applications of the principles of Mus 81 and 111 to compositional practice. Prerequisite: Mus 111, or equivalent, and consent of the department chairperson. Salerni

251. Special Topics (1-3)
Study of musical topics or work in musical composition not covered in regular courses, or continuation of study of topics or of projects in composition begun in regular courses. May be repeated for credit. Prerequisite: consent of the department chairperson.

Natural Science

J. Donald Ryan, Ph.D., *director,* natural science program.

This major provides students with a broad background in the fundamentals of mathematics and science and the opportunity to concentrate to a reasonable degree in one area of science.

The program is designed especially for the following: 1. those students who want preparation for graduate work or careers in certain of the derivative or interdisciplinary sciences or related professional fields (oceanography, astronomy, psycho-physiology, medicine or dentistry, etc.); 2. those students who plan to teach in secondary schools or community colleges; and 3. those students without fixed career objectives who want undergraduate training in science.

Students who register for the program are required to select an area of concentration (or option) that must be approved by the dean of the College of Arts and Science and the director of the program. The option may be chosen in chemistry, biology, geology, psychology, or in an approved interdisciplinary area (biophysics, marine science, biochemistry, computing and information science, etc.). Courses included in the option are worked out individually for the student by the major adviser.

Qualified students may be given permission at the end of the junior year to enter a program whereby they are able to begin work toward a graduate degree (master of arts, master of science, or master of education) during the senior year. Students enrolled in this program often complete all requirements for the master's degree with one year of study beyond the bachelor's degree.

required preliminary courses

Math 21, 22, 23	Analytical Geometry and Calculus (12)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Phys 21, 22	Introductory Physics II and Laboratory (5) *or*
Phys 13, 14	General Physics (4)
Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Geol 21, 22	Principles of Geology (4) *or*
Astron 1	The Solar System (3)
Biol 21, 22	Principles of Biology (4) *or*
Psych 1	Introduction to Psychology (3)

required major courses

Chem 51, 52,	Organic Chemistry *or*
53, 54	
Chem 31	Chemical Equilibria in Aqueous Systems (3)
Chem 187	Physical Chemistry (3)
Math	elective (3)
	option (24)

Note: The mathematics elective and courses included in the option are taken with approval of the major adviser.

Students registered for this major normally are expected to choose their option no later than the second semester of the sophomore year.

Philosophy

Professors. J. Ralph Lindgren, Ph.D., *chairperson;* Robert F. Barnes, Jr., Ph.D.; Steven Louis Goldman, Ph.D., Andrew W. Mellon Distinguished Professor in the Humanities and director of the Science, Technology and Society program; Thomas M. Haynes, Ph.D.; Norman P. Melchert, Ph.D.
Associate professor. John E. Hare, Ph.D.(on leave 1982-83).
Visiting assistant professor. Anne J. Jacobson (1982-83).
Visiting lecturer. James C. Erskine (1982-83).

Students considering extensive study in philosophy, whether as a major, a major in conjunction with a minor in another field, or as a minor, need answers to two main questions: What is the field of philosophy like? And what career possibilities are there for someone who major or minors in philosophy?

Philosophically inclined thinkers have always asked fundamental questions about the intellectual, moral, religious, social, and political aspects of human life. They have tried to subject these issues to rigorous analysis and provide thoughtful answers relevant to their time to such questions as: What is the relation of the individual to the state and its laws? Which human lifestyles and institutions are conceptually viable in a technological society? What are the implications of the scientific world view for our concepts of religion, freedom, and creativity? The analysis of the component issues in these and many more problems, the unearthing of presuppositions, the proposal of answers, and the critique of those proposals are the actual elements of philosophical investigation.

The study of philosophy provides preparation for a variety of careers either immediately after graduation or after further study beyond the bachelor degree. Careers requiring further study for which philosophy is an especially suitable preparation include: academic philosophy; law; some types of government service, e.g., urban planning; certain careers in business, e.g., management, personnel and industrial relations; the ministry; academic careers in areas other than philosophy, e.g., intellectual history, religion studies,

social and political theory, and information systems; and primary and secondary education.

Students majoring or minoring in philosophy who are not considering such fields find a wide variety of careers open to them after graduation. Capable philosophy students who choose their electives wisely find that the analytical, logical and discursive skills provided by philosophical training enable them to successfully pursue careers after graduation in such fields as communications, publishing, insurance, marketing, merchandising, social services, advertising, transportation, and utilities.

The curriculum of both the major and the minor in philosophy provides both ample flexibility for tailoring course work in philosophy to the developing interests of each student and wide latitude for supplementing these studies with work in other disciplines. The aim of these curricula is to enable each student, working closely with the departmental adviser, to develop a total curriculum in the light of individual interests and aspirations.

The Minor Program

The minor in philosophy consists of fifteen credit hours of course work. The specific courses to be taken by a student in this program are decided jointly by the student and the departmental adviser. These ordinarily include at least one course at the introductory level and one at the advanced level. Minor programs may be either of a general character or organized around a special theme such as: the philosophy of science, logic, ethics and value theory, the history of philosophy, and social philosophy.

The Major Program

The major in philosophy consists of thirty credit hours of course work. The specific courses to be taken are decided jointly by the student and the departmental adviser. All major programs include the following:

Phil 14	Foundations of Logic (3)
Phil 131	Ancient Philosophy (3)

plus two of the following:

Phil 2	Descartes to Sartre (3)
Phil 133	Medieval Philosophy (3)
Phil 135	Modern Philosophy (3)
Phil 139	Contemporary Philosophy (3)

plus three of the following:

Phil 128	Philosophy of Science (3)
Phil 214	Logical Theory (3)
Phil 215	Ethical Theory (3)
Phil 220	Knowledge and Justification (3)
Phil 250	The Minds of Men and Robots (3)
Phil 251	Action, Freewill, and Fate (3)

plus

Phil 291	Senior Seminar (3)

An additional six credit hours is selected with the counsel and approval of the departmental adviser. At least three of these six hours are to be from courses at the 100 level or above. Phil 221 does not count toward the major. At the discretion of the department, a major may be required to take and pass Engl 71, Expository Writing Workshop.

Undergraduate Courses

1. Socrates to Bacon (3) fall
Introduction to the ideas of the great philosophers in our tradition from early times through the Middle Ages. The problems they addressed, the solutions they proposed, and how they shaped our heritage. Melchert

2. Descartes to Sartre (3) spring
Introduction to the ideas of the great philosophers in our tradition from the Renaissance to recent times. The problems they addressed, the solutions they proposed, and how they shaped our heritage. May be taken independently of Phil 1. Melchert

10. Introduction to Philosophy (3) fall-spring
Basic philosophical questions, perennial and contemporary, such as the objectivity of morals, the justification of government, the place of mind and feeling in the world of matter and energy, the nature of knowledge and truth, and the reality of God.

13. Practical Logic (3) fall
Reaching conclusions and justifying conclusions—two kinds of reasoning. The role of logic in problem solving and decision-making processes. Comparison of deductive and inductive reasoning and justification. Practice in analysis, criticism, evaluation and construction of arguments. Emphasis on developing practical ability, with material drawn from real-life contexts. Barnes

14. Foundations of Logic (3) spring
The development of several symbolic languages as theoretical models for explaining certain logical features of ordinary English discourse, such as valid inference and necessary truth. Some significant general properties of these symbolic languages are studied. Barnes

15. Ethics (3) fall-spring
Development of the ability to thoughtfully formulate one's own moral orientation and to understand those of others through a critical study of major ethical theories such as rationalism, formalism, utilitarianism, and existentialism. Special attention is directed to such topics as moral character, judgment and responsibility.

75. (Psych 75) Behavior Control and Human Values (3) fall
Philosophical examination of operant conditioning techniques for controlling behavior. Value problems related to autonomy of individual choice, responsibility, rationality, freedom and dignity, and punishment. To what end shall behavior be controlled, and who will control the controllers. Prerequisite: an introductory course in either psychology or philosophy, or consent of the department chairperson. Melchert, Brody

81. The Meaning of Life (1) fall
Examination of religious and non-religious answers to the question of the meaning of life, and an analysis of what the question means. Melchert

100. Philosophy of Contemporary Civilization (3) fall-spring
Analysis of philosophical issues encountered in public and private decision making. Evaluation of the various techniques used in describing and prescribing alternate plausible ideals and structures for major act-forms and institutions (family, work, education, science, art, recreation, law, politics and religion).

115. Business Ethics (3) spring
Special problems in moral responsibility and ethical theory relating to contemporary business institutions, due to new dimensions of knowledge and evaluation, and emerging techniques of decision-making, planning, and management that characterize those institutions.

116. Medical Ethics (3) spring
Contemporary moral problems encountered in the practice of medicine examined in the light of ethical theories of the nature and foundation of rights and moral obligations. Abortion, euthanasia, genetic engineering, the nature of informed consent, the distribution of health care, etc. Hare

122. Philosophy of Law (3) spring
Analysis of the conceptual foundations of our legal system. Special attention is devoted to the nature and

validity of law, the relation of law and morality in the judicial decision, the concepts of liberty and justice in constitutional litigation, the theories of punishment in criminal law, and the nature and scope of responsibility in criminal and tort law. Lindgren

123. Aesthetics (3) fall
Theories, classical and modern, of the nature of beauty and the aesthetic experience. Practical criticism of some works of art, and examination of analogies between arts, and between art and nature. Hare

124. (RS 124) Reason and Religious Experience (3) spring
A critical look at some of the fundamental problems of religion: the nature of religious experience and belief, reason and revelation, the existence and nature of God, the problem of evil, and religious truth. Hare

128. Philosophy of Science (3) fall
Analysis of the structure and foundations of scientific knowledge. Topics such as explanation, empirical significance, operationalism, theory and observation, confirmation, and induction are investigated.

131. Ancient Philosophy (3) fall
Historical study of philosophy in the classical world from the pre-Socratics to Plato, Aristotle, and the Neo-Platonists, as the originators of the western tradition in philosophy and as interacting with the religious, political and scientific life of their times. Hare

133. Medieval Philosophy (3) spring, 1982
Historical study of philosophy from the fall of the Roman Empire to the Renaissance. Attention to Islamic, Jewish, and Christian traditions and their interaction with the scientific and cultural life of the period. Hare

135. Modern Philosophy (3) spring, 1983
Philosophers from the Renaissance to the mid-19th century. Descartes, Locke, Hume, Rousseau, Kant and Hegel. Their interaction with political, scientific, and religious thought of the period.

139. Contemporary Philosophy (3) spring
Philosophical thought from the mid-19th century to the present; pragmatism, linguistic analysis, existentialism, and Marxism. Truth and knowledge, values and moral judgment, meaning, and place of the individual in the physical world and society, and the impact of scientific method upon all of these. Melchert

143. (RS 143) Kierkegaard (1) spring
An introduction to the life and thought of Kierkegaard, the 19th-century Danish forerunner of existentialism, with a brief look at his impact on philosophy, theology, psychology and literature. Melchert

144. Karl Marx (1) fall
Introduction to the life and writings of Karl Marx, with special attention to his analyses of alienation, capitalism, history, revolution, and the Communist movement. Lindgren

150. (Engl 150) Media and Values (3) fall, odd-numbered years
How media and values are formed and reformed by their mutual interaction. Combines humanistic criticism with philosophical analysis to study a considerable range of the principal media (the human body, language, film, television, architecture, art) through which human values arise and take their place in the world. Historical, existentialist, phenomenological, and structuralist analyses are stressed. Individual student projects in media-value analysis or manipulation are required.

161. Science, Philosophy, and Religion (3)
Influence of philosophic thought and religious belief on Newtonian science from its emergence in the 17th century to its decline in the 20th century. Goldman

214. Logical Theory (3) spring, 1983
Conceptual foundations and philosophical significance of classical and modern logical theories. Analysis of the syntactic and semantic methods in logic, and their interrelations. Philosophical impact of important technical results, including Goedel's incompleteness theorem. Some discussion of potential future developments and alternative logics. Prerequisite: Phil 14 or consent of the department chairperson. Barnes

215. Contemporary Ethics (3) spring, 1983
Recent literature on some ethical theories and metaethical problems. Subsequent examination of selected substantive issues such as: ecological ethics; strategies and factors in moral education; mythic frameworks of various moralities; relation of ethics to social sciences and to practices in economics, law, religion. Prerequisite: Phil 15 or consent of the department chairperson.

220. Knowledge and Justification (3)
Extent and sources of knowledge, whether knowledge requires certainty, and how beliefs about the world are justified.

221. (Law 221) Sex-Discrimination and the Law (3) fall
A critical study of the law of sex-discrimination in areas of constitutional and labor law. A case approach that places special emphasis on the rights of employees and the obligations of employers. Topics include equal protection, equal employment opportunity, and affirmative action. Lindgren

228. Topics in the Philosophy of Science (3) spring
Themes in the natural, life and social sciences. May be repeated for credit as topic varies. Goldman

250. The Minds of Men and Robots (3) fall
Is the nature of thinking illuminated by what computers can do? Is the brain just a complex computer? Could a robot feel pain? Be angry? Recent work in artificial intelligence, psychology, and philosophy. Melchert

251. Action, Free Will, and Fate (3) spring
Are we free to act as we choose? Are we free to choose? The concept of action: intentions and actions, reasons and causes, and whether there can be deterministic explanations of actions. Melchert

260. Philosophy of the Social Sciences (3) fall, 1982
An analysis of the social sciences considered as programs for achieving understanding and control of man and society. Study is made of assumptions basic to, and problems incurred in, scientific methodology in general; the implications of these for the various social sciences are stressed.

271. Readings in Philosophy (1-3)
A course in readings designed primarily for the undergraduate philosophy majors and minors and graduate students in other disciplines. Prerequisite: consent of the department chairperson.

272. Readings in Philosophy (1-3)
A course of readings designed primarily for undergraduate philosophy majors and minors and graduate students in other disciplines. Prerequisite: consent of the department chairperson.

291. Senior Seminar (3)
Examination of selected topics for philosophy majors and minors and other advanced students.

Physics

Professors. W. Beall Fowler, Ph.D., *chairperson;* Ernest E. Bergmann, Ph.D.; Garold J. Borse, Ph.D.; Raymond J. Emrich, Ph.D.; Frank J. Feigl, Ph.D.; Robert T. Folk, Ph.D.; Alvin S. Kanofsky, Ph.D.; Yong W. Kim, Ph.D.; James A. McLennan, Ph.D.; Shelden H. Radin, Ph.D.; Wesley R. Smith, Ph.D.; Wesley J. Van Sciver, Ph.D.; George D. Watkins, Ph.D., Sherman Fairchild Professor of Solid-State Studies; Donald B. Wheeler, Jr., Ph.D.
Associate professors. Brent W. Benson, Ph.D.; Jeffrey A. Sands, Ph.D.; Russell A. Shaffer, Ph.D.
Assistant professor. Gary G. DeLeo, Ph.D.

Students may major in physics and earn a bachelor of science in engineering physics in the College of Engineering and Physical Sciences or major in physics in the College of Arts and Science and earn a bachelor of arts degree.

The engineering physics curriculum requires somewhat more physics and mathematics than the bachelor of arts major, while the latter requires more courses in the humanities, social sciences, and foreign languages or cultures. By proper choice of electives, either program can prepare a student for graduate work in physics. Because of the large number of approved and free electives, an engineering physics student can prepare for graduate work in physics or the physical aspects of other sciences or engineering disciplines, or can prepare for technical careers requiring a basic knowledge of physics. The bachelor of arts curriculum is particularly useful for those planning careers in areas where knowledge of physics is needed or useful, but is not the main subject, such as science writing, secondary school teaching, patent law, or medicine.

A comparison of the two curricula in terms of credit hours in various broad categories is given below.

	B.S. in engineering physics	**B.A. major in physics**
Freshman English	6	6
distribution courses (not including mathematics or science)	19	32 to 40 (depending on language requirements)
Required preliminary and major courses	65	57
approved electives	14	11
electives	20 to 28	6 to 14
total	124 to 132	120

A student in physics studies the basic laws of mechanics, heat and thermodynamics, electricity and magnetism, optics, relativity, quantum mechanics, and elementary particles. The student also studies applications of the basic theories to the description of bulk matter, including the mechanical, electric, magnetic, and thermal properties of solids, liquids, gases, and plasmas, and to the description of the structure of atoms and nuclei. In addition, the student develops the laboratory skills and techniques of the experimental physicist, skills that can be applied in the experimental search for new knowledge or in applications of the known theories.

Because of the fundamental nature of physics, students may use the major to prepare for many different careers. With judicious choice of electives, the physics student can prepare for graduate work in physics, in applied mathematics, in computer science, or in allied sciences such as biophysics, molecular biology, astrophysics, geophysics, chemical physics, materials engineering, meteorology, or physical oceanography. Further study toward careers in professional areas such as law or medicine is not uncommon.

In addition, the student may choose electives so as to prepare for graduate work in those areas of engineering that have a high science content such as: aeronautical engineering; nuclear engineering, including both fission and fusion devices; electrical engineering, including instrumentation, electronics, and solid-state devices, electrical discharges and other plasma-related areas; and mechanical engineering and mechanics, including fluids and continuum mechanics. Graduate work in any of these areas can prepare the student for a career in industrial research or development, or in university or college teaching and research.

The student who plans on employment immediately after the bachelor's degree may choose electives so as to develop the skills needed for a position in a particular area. For example, with judicious choices of electrical engineering and physics courses in electronics and solid-state physics, a strong applied background can be developed for employment in solid-state electronics. If the student chooses applied mathematics courses and computer courses to supplement the physics courses, a strong preparation can be achieved for employment in the many areas that use numerical methods in analysis and development.

Many other specialties may be developed by the student by appropriate use of electives so that the bachelor-degree student can offer an employer the advantages of a broad and fundamental science background combined with a significant concentration in a particular area of science, engineering, or applied mathematics.

Students are advised that admission to graduate school requires a minimum grade average, with a minimum average of B being typical. Also, some graduate schools require a reading knowledge of a modern foreign language.

Physics Major in Arts and Science

required preliminary courses

Chem 21, 22	Principles of Chemistry (5)
Math 21, 22, 23	Analytical Geometry and Calculus (12)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Phys 21, 22	Introductory Physics II and Laboratory (5)

required major courses

Phys 31	Introduction to Quantum Mechanics (3)
Phys 171	Proseminar (1)
Phys 190	Electronics (3)
Phys 212	Electricity and Magnetism I (3)
Phys 213	Electricity and Magnetism II (3)
Phys 215	Particles and Fields I (3)
Phys 260	Laboratory Techniques (2) *or*
Phys 261	Optics, Spectroscopy, and Quantum Physics Laboratory (2)
Phys 340	Thermal Physics (3)
Phys 362	Atomic and Molecular Structure (3)
Math 205	Linear Methods (3)
Math 322	Methods of Applied Analysis I (3)
	approved science, mathematics, or technical electives (11)

The engineering physics curriculum below may serve as a useful guide in designing the sequence for the bachelor of arts physics major.

Engineering Physics in Engineering and Physical Sciences

freshman year **(see page 46)**

sophomore year, first semester (16 credits)

Phys 21, 22	Introductory Physics II and Laboratory (5)
Math 23	Analytical Geometry and Calculus III (4)
	Elective (3)
Eco 1	Economics (4)

sophomore year, second semester (18)

Phys 31	Introduction to Quantum Mechanics (3)
Phys 190	Electronics (3)
Math 205	Linear Methods (3)
	General Studies requirement (3)
	electives (6)

junior year, first semester (14-17)

Phys 212	Electricity and Magnetism I (3)
Phys 215	Particles and Fields I (3)
Phys 260	Laboratory Techniques (2)
Math 322	Methods of Applied Analysis I (3)
	electives (3-6)

junior year, second semester (17)

Phys 213	Electricity and Magnetism II (3)
Phys 261	Optics, Spectroscopy, and Quantum Physics Laboratory (2)
Phys 362	Atomic and Molecular Structure (3)
	General Studies requirement (3)
	electives (6)

senior year, first semester (14-17)

Phys 216	Particles and Fields II (3)
Phys 340	Thermal Physics (3)
	General Studies requirement (3)
	electives (5-8)

senior year, second semester (15)

Phys 171	Proseminar (1)
	General Studies requirement (3)
	electives (11)

The electives include at least fourteen credit hours of approved technical electives, including two of the courses Phys 346, 352, 363, 364, 365, 366, 367, 368 and 369.

Special opportunities. A majority of physics and engineering physics majors take advantage of opportunities to participate in research under the direction of a faculty member. This can be arranged informally or as a senior research course. In addition, a number of students receive financial support to do research during the summer between junior and senior years, either as a Sherman Fairchild Scholar or a summer research participant.

The use of electives. The electives provided in both physics curricula provide the student with an opportunity to develop special interests and to prepare for graduate work in various allied areas. The student is urged to reflect upon how to take advantage of this opportunity. A student contemplating graduate work in physics should consider the many upper-level physics and mathematics courses available, as well as some of the beginning graduate courses. In addition, note that some graduate schools require a reading knowledge of a modern foreign language.

Students contemplating using electives to develop a special area of interest should try to plan such a program as soon as possible by consultation with members of the faculty. Since many possibilities exist, it is impractical to list all such programs. Instead, two such programs are listed below to serve as guides for those with interests in those areas and to serve as models for those interested in developing their own programs in other areas.

Biophysics

Biol 21	Principles of Biology (3)
Biol 28	Genetics (3)
Biol 135	Microbiology (3)
Biol 320	Cell Physiology (3)
Chem 51, 52	Organic Chemistry (6)
Chem 371	Elements of Biochemistry I (3)
Chem 372	Elements of Biochemistry II (3)
Phys 367	Introduction to Molecular Biophysics (3)
Phys 368	Molecular Biophysics (3)

Soild-State Electronics

Met 91	Elements of Materials Engineering (3)
ECE 125	Circuits and Systems (3)
ECE 126	Physical Electronics (3)
ECE 123	Electronic Circuits (3)
ECE 308	Transistor Theory (3)
ECE 351	Microelectronics (3)
Phys 363	Physics of Solids (3)

Undergraduate Courses in Physics

11. Introductory Physics I (4) fall-spring
Kinematics, frames of reference, laws of motion in Newtonian theory and in special relativity, conservation laws, as applied to the mechanics of mass points; temperature, heat and the laws of thermodynamics; kinetic theory of gases. Two lectures and two recitations per week. Prerequisite: Math 21, 31 or 41, previously or concurrently. Smith or Sands

12. Introductory Physics Laboratory I (1) fall-spring
A laboratory course taken concurrently with Phys 11. Experiments in mechanics, heat, and DC electrical circuits. One three-hour laboratory period per week.

13. General Physics (3) spring
A continuation of Phys 11, primarily for students in the College of Arts and Science and premedical students. Electrostatics, electromagnetism, light, fluid mechanics, atomic physics, nuclear physics and radioactivity, introduction to biophysics. Prerequisites: Phys 11 and Math 21, 31 or 41. Van Sciver

14. General Physics Laboratory (1) spring
A laboratory course to be taken concurrently with Phys 13. Prerequisites: Phys 12; Phys 13, preferably concurrently.

21. Introductory Physics II (4) fall-spring
A continuation of Phys 11. Electrostatics and magnetostatics; DC circuits; Maxwell's equations; waves; physical and geometrical optics; introduction to modern physics. Two lectures and two recitations per week. Prerequisites: Phys 11; Math 23, 32, or 44, previously or concurrently. Shaffer or Benson

22. Introductory Physics Laboratory II (1) fall-spring
A laboratory course to be taken concurrently with Phys 21. One three-hour laboratory period per week. Prerequisites: Phys 12; Phys 21, preferably concurrently.

31. Introduction to Quantum Mechanics (3) fall-spring
Experimental basis and historical development of quantum mechanics; the Schrodinger equation; one-dimensional problems; angular momentum and the hydrogen atom; many-electron systems; spectra; selected applications. Three lectures per week. Prerequisites: Phys 13 or 21; Math 205, previously or concurrently. Van Sciver, Emrich, Watkins, DeLeo

42. Physics for Poets (3) spring
The principal concepts and discoveries of physics from Newton's laws through quantum mechanics and elementary particles are presented in a concise manner. The relevance of physics to modern society is also

discussed. The laboratory provides direct exposure to modern technological devices such as integrated circuits and computers, and it also serves to demonstrate the concepts covered in lectures. The purpose of the course is to provide students majoring in subjects other than science and engineering with sufficient background to enable them to cope with, appreciate, and understand the science and technology of modern society. High school physics is not assumed. Two recitation periods and one laboratory period per week. No prerequisites. Kanofsky

171. Physics Proseminar (1) spring
Discussion of current problems in physics. Intended for seniors majoring in the field. Radin

190. Electronics (3) spring
DC and AC circuits, diodes, transistors, operational amplifiers, oscillators, and digital circuitry. Two laboratories and one recitation per week. Prerequisites: Phys 21 and 22, or Phys 13 and 14. Smith

For Advanced Undergraduates And Graduate Students

212. Electricity and Magnetism I (3) fall
Electrostatics, magnetostatics, and electromagnetic induction. Prerequisites: Phys 21 or 13; Math 205, previously or concurrently. Folk

213. Electricity and Magnetism II (3) spring
Maxwell's equations; electromagnetic waves with applications to optics. Prerequisite: Phys 212. Folk

215. Particles and Fields I (3) fall
Foundations of mechanics of mass points and systems of particles. Conserved quantities. Force laws, mathematical formulation and solution of the motion of mass points and systems of mass points. Prerequisites: Phys 21 or Phys 13; Math 205, previously or concurrently. Wheeler

216. Particles and Fields II (3) fall
Continuation of Phys 215. Rigid body motion. Elasticity and fluid mechanics, employing tensor notation. Sound waves. Dimensional analysis and similitude. Lagrange generalized coordinates and solutions of problems by Lagrange equations. Prerequisite: Phys 215. Radin

260. Laboratory Techniques (2) fall
Laboratory practice, including machine shop, vacuum systems, electronic instrumentation, computers and integrated circuits, high-voltage measurements, counting and statistics. Prerequisites: Phys 21 and 22, or Phys 13 and 14. Kanofsky

261. Optics, Spectroscopy, and Quantum Physics Laboratory (2) spring
Experiments in geometrical optics, interference and diffraction, spectroscopy, lasers, and quantum phenomena. Prerequisites: Phys 21 and 22, or Phys 13 and 14. Bergmann, Wheeler

273. Research (2-3) fall-spring
Participation in current research projects being carried out within the department. Intended for seniors majoring in the field. May be repeated once for credit.

281. Basic Physics I (3) summer
A course designed especially for secondary-school teachers in the master teacher progam. Presupposing a background of two semesters of college mathematics through differential and integral calculus and of two semesters of college physics, the principles of physics are presented with emphasis on their fundamental nature rather than on their applications. Open only to secondary-school teachers and those planning to undertake teaching of secondary-school physics.

282. Basic Physics II (3) summer
Continuation of Phys 281.

300. Apprentice Teaching in Physics (1-3)

312. Advanced Laboratory (1) fall-spring
Experiments in modern physics designed to introduce students to measuring techniques and phenomena of current interest. Prerequisites: senior or graduate standing in the field, or consent of the department chairperson. May be repeated for credit.

340. Thermal Physics (3) fall
Basic principles of thermodynamics, kinetic theory, and statistical mechanics, with emphasis on applications to classical and quantum mechanical physical systems. Prerequisites: Phys 13 or 21, and Math 23, 32 or 44. Feigl

346. Physics of Developing Energy Sources (3) spring
Basic concepts, theoretical development, and experimental techniques pertaining to developing energy sources. Topics include thermonuclear, magneto-hydrodynamic, solar and other potential sources of energy. Prerequisite: senior standing in the College of Engineering and Physical Sciences, or consent of the department chairperson. Kim

352. Modern Optics (3) spring
Paraxial optics, wave and vectorial theory of light, coherence and interference, diffraction, crystal optics, and lasers. Prerequisites: Math 23, and Phys 21 or 13. Radin

362. Atomic and Molecular Structure (3) spring
Structure of atoms and molecules, especially as related to their spectra. Prerequisite: Phys 31 or Chem 191. Shaffer

363. Physics of Solids (3) fall
Introduction to the theory of solids with particular reference to the physics of metals and semiconductors. Prerequisite: Phys 31 or Met 316 or Chem 191. DeLeo

364. Nuclear Physics (3) spring
Nuclear models and properties of nuclei. Interaction of nuclear radiation with matter and applications. Radioactive decay; phenomenology and theory. Radiation and particle detectors. Nuclear reactions. High-energy physics. Accelerators. Practical nuclear physics applications. Prerequisites: Phys 31 and Math 205. Folk

365. Physics of Fluids (3) spring
Concepts of fluid dynamics; continuum and molecular approaches; waves, shocks and nozzle flows; nature of turbulence; experimental methods of study. Prerequisites: Phys 212 or ECE 231, and Phys 340 or ME 104 or equivalent, previously or concurrently. Smith

366. Ocean Physics (3)
Underwater sound and optics, thermodynamics of the oceans, other topics in physical oceanography such as currents, tides and waves. Prerequisites: Math 205 and Phys 21 or 13. Van Sciver

367. Introduction to Molecular Biophysics (3) fall
A development of the molecular basis of life in terms of physical principles. Topics include molecular biology of the gene, energy flow as an organizing factor in biology, intra-and inter-molecular interactions, and the determination of macro-molecular structure and function. Techniques discussed include ultracentrifugation, optical spectroscopy, and X-ray diffraction. Prerequisite: Phys 13 or 21. Benson, Sands

368. Molecular Biophysics (3) spring
Further topics in molecular biophysics including the problems of membrane structure and function, the action of radiation on cells and the structure of cell water. Techniques discussed include electron spin resonance, nuclear magnetic resonance, molecular probes and

calorimetry. Prerequisites: Phys 367 or consent of the department chairperson. Sands, Benson

369. Introduction to Quantum Mechanics (3) fall
Principles of quantum mechanics: Schrodinger, Heisenberg, and Dirac formulations. Applications to simple problems. Prerequisites: Phys 31, Math 205; Phys 216, previously or concurrently. McLennan

372. Special Topics in Physics (1-3)
Special topics in physics not sufficiently covered in the general courses. Lecture and recitations or conferences.

For Graduate Students

The department of physics has concentrated its research activities within several fields of physics, with the result that a number of projects are available in each area. Current departmental research activities include the following:

Solid-state physics (experimental). Optical properties of insulators, defects in insulators and semiconductors, electron paramagnetic resonance, properties of thin films, semiconductor physics.

Solid-state physics (theoretical). Energy band calculations in insulators, excited states and lifetimes of defects, properties of impurities in insulators and semiconductors.

Molecular biophysics. Magnetic resonance studies of nucleic acid derivatives, molecular virology. Membrane biophysics.

Plasma spectroscopy. Collisional and collisionless phenomena of very dense plasmas.

Nuclear theory. The few nucleon problem, nuclear structure theory.

Physics of fluids. Microscopic fluctuations in a flow. Shock-induced reactions in gases and phase transitions at liquid-vapor interfaces. Non-equilibrium fluctuations in gases and small particle dynamics.

Statistical physics. Kinetic theory, transport in plasmas with strong magnetic fields, statistical basis of hydrodynamics, nonlinear processes.

Elementary particles (experimental). Experiments are performed both at Lehigh and at the various national accelerator facilities at Fermilab, Argonne ZGS, and Brookhaven AGS. These include cosmic ray studies; production of jets (Fermilab); high-energy particle channeling (Fermilab); Kaon-induced hypernuclei (AGS); particle-nuclei reactions (ZGS).

Elementary particles (theoretical). Properties of leptons and vector bosons, weak and electromagnetic interactions. Quark-Glauber calculations of elastic and inelastic scattering.

Laser physics. Construction of gas lasers and studies of their characteristics; use of gas lasers in determination of oscillator strength and atomic parameters; mode structure; holography.

Van de Graaff studies. Experiments to study nuclear reactions, channeling, new instrumentation techniques, Rutherford back-scattering using the Lehigh van de Graaff accelerator.

Candidates for advanced degrees normally will have completed, before beginning their graduate studies, the requirements for a bachelor degree with a major in physics, including advanced mathematics beyond differential and integral calculus. Students lacking the equivalent of this preparation will make up deficiencies in addition to taking the specified work for the degree sought.

Doctoral candidates may be required by their thesis committee to demonstrate a reading knowledge of one language, usually chosen from French, German or Russian. Some graduate work in mathematics is usually required; and certain advanced courses in other fields, notably mechanics, metallurgy and materials engineering, electrical engineering, and chemistry, may be included in a graduate program. Further details regarding the special requirements for degrees in physics may be obtained on application to the department chairperson.

At least eight semester hours of general college physics using calculus are required for admission to all 200- and 300-level courses. Additional prerequisites for individual courses are noted in the course descriptions. Admission to 400-level courses generally is predicated on satisfactory completion of corresponding courses in the 200- and 300-level groups or their equivalent.

Facilities for the various areas of experimental research include three electron spin resonance laboratories; a laboratory for optical detection of magnetic resonance; ultraviolet, visible, and infrared spectrophotometers; liquid nitrogen, hydrogen, and helium cryogenic equipment; several shock tubes; film scanning apparatus; cosmic ray detectors; five high-power lasers (two Argon-ion lasers, a tunable pulsed dye laser, a Ruby laser, and a mode-locked, Q-switched Nd glass laser); crystal-growing facilities; a mass spectrometer, large interferometers, signal average, electron microscope, and a high-density plasma source; several minicomputers; and an ultracentrifuge.

The adjacent Sherman Fairchild Laboratory, completed in 1976, is the hub of solid-state activity. It houses a 3 MeV van de Graaff accelerator, a number of other solid-state laboratories, and research facilities. The van de Graaff acclerator is used to study radiation effects in solids, to analyze impurity distributions in thin films, and in instrumentation, channeling, and nuclear studies.

Excellent facilities for the preparation of solid-state materials and fabrication of simple solid-state devices are available in this laboratory and are heavily used by physics students working on solid-state problems. Extensive instrumentation for solid-state measurements (optical absorption and luminescence, ESR, electrical properties, cryogenic facilities, ion-beam surface analysis, among others) are found in this laboratory.

Faculty from the physics department participate in the inter-disciplinary master of science and doctor of philosophy programs in molecular biology. These are described in Section IV.

Graduate Courses in Physics

420. Theoretical Physics (3) fall
This and the three courses Phys 421, 422, and 423 cover the classical theory of particles and fields. Phys 420 includes the variational methods of classical mechanics, methods of Hamilton and Lagrange, canonical transformations, Hamilton-Jacobi theory. Bergmann

421. Theoretical Physics (3) spring
Theory of elasticity; fluid dynamics; tensor analysis; electrostatics and magnetostatics. Prerequisite: Phys 420. Emrich

422. Advanced Theoretical Physics (3) fall
Electromagnetic radiation; dynamics of charged particles; multipole fields; special theory of relativity and covariant formulation of electrodynamics. Prerequisite: Phys 421. Folk

423. Advanced Theoretical Physics (3)
Electrodynamics in anisotropic media; physical optics; theory of diffraction and application to holography; applications of electrodynamics in various fields of physics. Prerequisite: Phys 422. Bergmann

424. Quantum Mechanics (3) spring
General principles of quantum theory; approximation methods; spectra; symmetry laws; theory of scattering. Prerequisite: Phys 369 or equivalent. Watkins

425. Quantum Mechanics (3) fall, even-numbered years
A continuation of Phys 424. Relativistic quantum theory of the electron; theory of radiation. McLennan

428. Methods of Mathematical Physics (3) fall
The equations of theoretical physics and the methods of their solution. Borse

429. Methods of Mathematical Physics (3) spring
Continuation of Phys 428. Borse

431. Theory of Solids (3) spring, even-numbered years
Advanced topics in the theory of the electronic structure of solids. Many-electron theory. Theory of transport phenomena. Magnetic properties, optical properties. Superconductivity. Point imperfections. Desirable preparation: Phys 363 and Phys 424. Fowler

434. Solids and Radiation (3)
Phenomena in solids resulting from interaction with electromagnetic radiation or charged particles. Current theories of energy absorption, transport and emission. Prerequisite: Phys 363 or equivalent.

442. Statistical Mechanics (3) fall
General principles of statistical mechanics with application to thermodynamics and the equilibrium properties of matter. Prerequisites: Phys 340 and 369. Kim

443. Statistical Mechanics (3) spring, odd-numbered years
A continuation of Phys 442. Applications of kinetic theory and statistical mechanics to nonequilibrium processes; non-equilibrium thermodynamics. Prerequisite: Phys 442. McLennan

447. (Biol 447, Chem 447) Experimental Molecular Biology (3)
A survey of current research in molecular biology.

451. Topics in Biophysics (1-3)
An intensive study of recent advances in a selected area of biophysics. May be repeated for credit when a different topic is offered. Prerequisite: Phys 368. Benson or Sands

462. Theories of Elementary Particle Interactions (3)
Relativistic quantum theory with applications to the strong, electromagnetic and weak interactions of elementary particles. Prerequisite: Phys 425. Shaffer

465. Nuclear and Elementary Particle Physics (3) spring, even-numbered years
Nuclear structure and phenomena; interactions among elementary particles and methods of studying them. Kanofsky

467. Nuclear Theory (3) spring, odd-numbered years
Theory of low-energy nuclear phenomena within the framework of nonrelativistic quantum mechanics. Borse

471. (Mech 411) Continuum Mechanics (3)
An introduction to the continuum theories of the mechanics of solids and fluids. This includes a discussion of the mechanical and thermodynamical bases of the subject, as well as the usë of invariance principles in formulating constitutive equations. Applications of the theories to specific problems are given. G. Smith, Varley

472. Special Topics in Physics (1-3)
Selected topics not sufficiently covered in the more general courses. May be repeated for credit.

474. Seminar in Modern Physics (3)
Discussion of important advances in experimental physics. May be repeated for credit when a different topic is offered.

475. Seminar in Modern Physics (3)
Discussion of important advances in theoretical physics. May be repeated for credit when a different topic is offered.

491. Research (3)
Research problems in experimental or theoretical physics.

492. Research (3)
Continuation of Phys 491. May be repeated for credit.

Portuguese

See listings under Modern Foreign Languages.

Psychology

Professors. Arthur L. Brody, Ph.D.; Donald T. Campbell, Ph.D., University Professor of Social Relations and Psychology; George K. Shortess, Ph.D.
Associate professors. Edwin J. Kay, Ph.D.; William Newman, Ph.D., *chairperson;* John G. Nyby, Ph.D.; Martin L. Richter, Ph.D.
Assistant professors. Maureen A. Callanan, Ph.D.; Lawrence A. Fehr, Ph.D.; Richard P. High, Ph.D.; Diane T. Hyland, Ph.D.
Adjunct professors. Joyce D. Clark, Ph.D.; David W. Durka, Ph.D.; Mervin P. Smolinsky, Ph.D.

The bachelor of arts in psychology is a natural science major requiring a minimum of thiry credit hours in psychology as defined below. Second-semester freshmen who have completed Psych 1 can enroll in the 100-level courses by petition, and should check with the chairperson of the psychology department if interested.

Required Major Courses

Psych 1	Introduction to Psychology (3) NS SS fall-spring
Psych 113	Psychological Research and Statistics (3) NS fall
Psych 114	Psychological Research and Statistics (3) NS spring
Psych 115	History of Modern Psychology (3) SS fall

Plus the following

either

Psych 107	Child Psychology (3) SS fall
Psych 154	Clinical Approaches to Human Behavior (3) SS spring

either

Psych 171	Learning Processes and Applications (3) NS fall
Psych 176	Introduction to Psychophysiology (3) NS spring

at least two from

Psych 305	Abnormal Psychology (3) SS fall
Psych 331	Humanistic Psychology (3) SS spring
Psych 342	Systems and Theories of Contemporary Psychology (3) SS
Psych 351	Piaget (3) SS
Psych 353	Personality Theory (3) SS fall

at least two from

Psych 307	Cognitive Psychology (3) NS fall
Psych 371	Learning (3) NS spring
Psych 373	Sensation and Perception (3) NS spring
Psych 375	Physiological Psychology (3) NS fall
Psych 382	Comparative Psychology (3) NS spring

Additional Required Courses. These fulfill College of Arts and Science distribution requirements. They are elective courses that bring the credit-hour total to 120.

Recommended Electives

The bachelor of arts program in psychology is a flexible preparation for a number of fields. With a suitable selection of additional courses, students can prepare

themselves for graduate study in clinical psychology, developmental psychology, social psychology, or personality, or for careers in areas for which psychology is a desirable and relevant major, e.g., law, social work, nursing, or special education. Courses recommended, in addition to those major courses listed above, are:

Psych 161	Independent Research (1-3)
Psych 162	Psychological Field Work (1-3)
Psych 271, 272	Thesis (6)
Psych 309	Statistical Analysis (3)
SR 21	Social Psychology (3)
Math 41	BMSS Calculus (3)
Biol 21	Principles of Biology (3)
Biol 28	Genetics (3)

With greater emphasis on mathematics and science, the program provides preparation for graduate study in experimental psychology, medicine or dentistry. In this case, additonal recommended courses are:

Psych 161	Independent Research (1-3)
Psych 162	Psychological Field Work (1-3)
Psych 271, 272	Thesis (6)
Psych 303	Mathematical Psychology (3)
Psych 309	Statistical Analysis (3)
Psych 372	Learning Laboratory (1)
Psych 374	Sensation and Perception Laboratory (1)
Psych 376	Physiological Psychology Laboratory (1)
Math 21, 22, 23	Analytic Geometry and Calculus (12) *or*
Math 31, 32	Calculus (8) *or*
Math 41, 42, 43, 44	BMSS Calculus, Probability, Linear Algebra, Calculus (12)
Biol 21, 22	Principles of Biology and Laboratory (4)
Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Phil 42 or 261 or 301	philosophy of science course (3)

plus additonal electives in mathematics, probability, statistics, computing and information science, biology, chemistry, and physics.

All students planning to pursue graduate study in psychology should take:

Psych 271, 272	Thesis (6)
Psych 309	Statistical Analysis (3)

Of particular interest to those students interested in a career business administration is the five-year Arts BA-MBA degree. In this option, a student majors in psychology, takes requisite courses in the College of Business and Economics, and then takes an additional year of study in business administration beyond the bachelor's degree. The Arts BA-MBA program is described in Section III. There are, of course, many other possibilities. Students interested in formulating a particular career-based program of study should consult the department chairperson.

Honors Program in Psychology

The honors program in psychology permits psychology majors of unusual academic ability and interest to explore areas of psychology in greater depth than the curricula normally allow. Under faculty supervision, a student normally spends the first semester of the senior year doing library research, learning the appropriate methodology, and preparing a written proposal. In the second semester the proposal is implemented, culminating in a written honors thesis. Successful completion of this program results in "Departmental Honors" being affixed to the student's transcript.

Eligibility requirements. Eligible students must be psychology majors; have completed the first semester of the junior year with an over-all GPA of 3.0; and have completed a minimum of four psychology courses in a grade-point average (GPA) of 3.3.

Interested students should contact the chairperson.

The Psychology Minor

The psychology minor consists of fifteen credit hours in psychology beyond the introductory course (Psych 1, 21). At least one of these courses must be above the 200 level. The student should consult the department chairperson no later than the fifth semester regarding course selection.

Undergraduate Courses

The entry NS or SS applies only to psychology courses and refers to Natural Science or Social Science distribution requirements. Some listings also state the semester in which the course is customarily offered.

1. Introduction to Psychology (3) NS SS fall-spring
Psychology as a science of behavior. Natural science aspects such as learning, sensation-perception, and physiological bases; and social science aspects such as human development, intelligence, and personality. Methodologies appropriate to these areas, and related societal problems.

21. (Soc Psych 21) Social Psychology (3) SS
Theories, methods of investigation, and results of research in social psychology with emphasis on psychological processes in social behavior, social attitudes, group behavior, and social interaction. Not offered to students who have had Soc Psych 7.

65. Perception and the Visual Arts (3) NS
Perceptual and cognitive theories and principles as related to visual fine arts and aesthetic experience. Shortess

75. (Phil 75) Behavior Control and Human Values (3) SS spring
Philosophical examination of operant conditioning techniques for controlling behavior. Value problems related to autonomy of individual choice, responsibility, rationality, freedom and dignity, and punishment. To what end shall behavior be controlled, and who will control the controllers? Prerequisite: an introductory course in either psychology or philosophy, or consent of the department chairperson. Brody, Melchert

Psych 81. Psychology and Law (3) SS spring
Problems with the concepts of insanity, psychosis, and therapy; commitment procedures, incompetency, and the insanity defense; patient's rights; psychological tests, discrimination and privacy; school and family law problems; and the expert witness and confidentiality. Brody

107. Child Psychology (3) SS fall
Theories and data concerning the development of the human organism from fetus to adolescent. Emphasis is placed on the methods and techniques employed. Prerequisite: Psych 1. Fehr, Callanan

108. Adolescent and Adult Psychology (3) SS spring
Descriptions and explanations of cognitive, personality, and physical development during the adolescent and early adult years. The stresses of adolescence and the difficulties that individuals encounter in their initial attempts to function as adults. Prerequisite: Psych 1. Fehr, Callanan

109. (Soc Psych 109) Adulthood and Aging: Social and Psychological Perspectives (3) SS
Psychological, sociological and other social science

approaches to the latter two-thirds of the life span. Age stratification and distribution patterns, attitudes of aging, social behavior of older adults, widowhood, issues of retirement and use of leisure time. Blank, Hyland

113. Psychological Research and Statistics (3) NS fall
Basic data, research methods, and statistics in a variety of subject areas. Design of experiments with human and other animals; data collection, analyses, reports. Prerequisite: Psych 1. Kay, Brody

114. Psychological Research and Statistics (3) NS spring
Continuation of Psych 113; independent research project. Prerequisite: Psych 113. Kay, Brody

115. History of Modern Psychology (3) SS spring
Origin and development of major theories within perception, cognition, biological, clinical, personality, developmental, learning. Nineteenth and twentieth century thought to provide an overview of psychology as a discipline. Prerequisite: Psych 1 or consent of the department chairperson. High

121. Encountering Self and Others (3) SS fall-spring
An experientially oriented course to facilitate personal growth and develop a fuller awareness of personal functioning and interpersonal perception and communication. Pass-fail grading. Prerequisite: consent of the department chairperson. Newman, Durka

131. Psychology of Women (3) SS fall
Biological, cross-cultural, sociological and psychological perspectives on women, with reference to personal experience where appropriate. Prerequisite: Psych 1 or an introductory social relations course, and consent of the department chairperson. Hyland

154. Clinical Approaches to Human Behavior (3) SS spring
Therapeutic approaches and their theoretical foundations: Psychoanalysis, client-centered, Gestalt, rational-emotive, behavioral, and existential therapies. This is not a how-to-do-it course in psychotherapy. Prerequisite: Psych 1. Clark

160. Independent Study (1-3) NS SS fall-spring
Readings on topics selected in consultation with a staff member. Prerequisites: Psych 1 and consent of the department chairperson. May be repeated for credit. Fulfills natural science or social science distribution requirements for students in the College of Arts and Science by petition only.

161. Independent Research Seminar (1-3) NS SS fall-spring
Individual research projects are designed and executed in close collaboration with the faculty. Students meet with the seminar director to communicate about and critique each other's projects. Prerequisites: Psych 114 and consent of the department chairperson. May be repeated for credit. Fulfills NS or SS distribution requirements for students in the College of Arts and Science by petition only.

162. Psychological Field Work (1-3) SS fall-spring
Work-study practice including supervised experience in one of several local agencies. Development of familiarity with the operations of the agency and working with individual patients or students. Prerequisites: Psych 1 and consent of the department chairperson. Fehr

171. Learning Processes and Applications (3) NS fall
Experimental data on animal and human conditioning and learning. Applications to mental health, mental retardation, education. Prerequisite: Psych 1. Brody, Richter

176. Introduction to Psychophysiology (3) NS spring
Physiological correlates of behaviorally defined psychological conditions in humans: sleep, stress, emotion, and anxiety; psychosomatic disorders, lie detection, and psychopathology. Prerequisite: Psych 1. Nyby, Shortess

201. Industrial Psychology (3) SS spring
Psychological concepts and methods applied to business and industrial settings. Personnel selection, placement and training, leadership, work motivation, job satisfaction and consumer behavior. Prerequisite: Psych 1.

271. Thesis (3) fall
Written report: Literature review and design of project in selected area of psychology. Intended for senior majors in psychology only. Prerequisite: consent of the chairperson.

272. Thesis (3) spring
Execution of project designed in Psych 271. Final report and oral presentation. Prerequisite: Psych 271 and consent of the department chairperson.

300. Apprentice Teaching in Pyschology (1-3) NS SS fall-spring
Fulfills Natural Science or Social Science distribution requirements for students in the College of Arts and Science by petition only.

303. Mathematical Models in Psychology (3) NS
The application of mathematics in psychology, including models for psychophysics, learning acquisition curves, discrimination learning, concept formation and probability learning. Prerequisite: Psych 114, or consent of the department chairperson. Kay

305. Abnormal Psychology (3) SS fall
The patterns, causes, and treatment of various forms of abnormal behavior. Supplemented by sessions at Allentown State Hospital. Prerequisites: Psych 1, and three additional hours of psychology or consent of the department chairperson. Fehr

307. Cognitive Psychology (3) NS fall
Processing of information by human beings. Topics include contemporary theories of perception, attention, memory, and decision-making. Prerequisite: Psych 1. High

308. (CIS 320) Information Processing: Human and Machine (3) NS
Study of the identification, storage, retrieval, and use of auditory and visual inputs in decision-making contexts. Human and mechanical information processes, their similarities and differences. Rubenstein

309. Statistical Anaylsis (3) NS fall
Theory and practice of data in psychology. Descriptive statistics. Hypothesis testing. Tests of inference: chi-square, t-test, correlation, analyses of variance. Kay, Richter

320. (HD 320) Psycholinguistics (3) spring
Study of the experimental and observational literature on psychological processes involved in the production, comprehension, and use of language by adults. Rubenstein

324. (HD 324) Life-Span Cognitive Development (3) SS
Changes in perception, learning, memory, and problem-solving from infancy to old age. Rubenstein

331. Humanistic Psychology (3) SS spring
The literature of and metaphors underlying the humanistic point of view in psychology. These "models of

man" are contrasted with models underlying other modes of psychological inquiry. Prerequisite: Psych 1. Newman

335. (Biol 335) Animal Behavior (3)
Discussion of the behavior of invertebrates and vertebrates and analysis of the physiological mechanisms responsible for behavioral actions. Emphasis on perception, environmental stimuli, and adaptive value of special behavior patterns. Prerequisite: Biol 21 or consent of the department chairperson.

337. (Biol 337) Sociobiology (3)
Social systems of vertebrate and invertebrate groups. Emphasis on ecological and evolutionary factors that influence social behavior. Prerequisite: Biol 21 or consent of department chairperson. Not open to students who have taken Biol 498.

342. Systems and Theories of Contemporary Psychology (3) SS
Survey of the theories and world view of the various approaches employed by contemporary psychologists: behaviorism, cognitivism, genetic epistemology, humanism, and phenomenological psychology. Philosophical problems that effect approaches: nature of explanation; mind-body problem. Prerequisite: two psychology courses above the 200-level or consent of the department chairperson. High

343. (S.R. 343) Scientific Methods for Applied Social Sciences (3)
Problems in the application of scientific methods in policy relevant research. Prerequisite: introductory statistics or consent of the department chairperson. Campbell

345. (S.R. 345) Seminar on the Social Evolution of Complex Organizations (3)
Topic varies from year to year. May be taken more than once. Possible topics: Evolution of archaic city states. Role of theism and theocracy. Moral norms as socially evolved curbs to the dysfunctional species-personality produced by biological evolution. Parallel problems in modern bureaucracy. Campbell

347. (S.R. 347) Seminar on Sociology and Psychology of Science (3)
Specific topic varies from year to year. May be taken more than once. General focus is on those sociological and psychological processes in science that are relevant to the credibility of a science's claim to be improving its validity. Campbell

351. Piaget (3) SS
Analysis of the viability of Piaget's approach to development during the childhood years. Students examine some of Piaget's early writings and compare their approach to cognitive development with those of other relevant authors. Fehr, Callanan

352. (I & C 331) Emotional and Behavioral Disorders (3) SS
Definition, classification, etiology, treatment, and historical perspective of individuals with emotional and behavioral disorders.

353. Personality Theory (3) SS fall
Review and critique of theories of personality and their associated systems of psychotherapy. Includes developing knowledge and theory about people as well as the theoretical concepts themselves. Prerequisite: Psych 1. Fehr, Hyland

354. Personality Assessment (3) SS spring
Methods of describing and measuring personality. Observational techniques, interviews, self-report inventories, intelligence tests, and projective tests. Prerequisites: Psych 1, and consent of the department chairperson. Hyland

371. (HD 451) Learning (3) NS spring
Principles of learning with emphasis on reinforcement, discrimination, motivation, verbal learning and memory. Critical evaluation of classical and contemporary theories of learning. Prerequisite: Psych 1. Brody, Richter

372. Learning Laboratory (1) NS spring
Experimentation on the learning process utilizing animal and human subjects. Prerequisites: Psych 111 or 114; Psych 371, previously or concurrently. Brody, Richter

373. Sensation and Perception (3) NS spring
Receptor processes of vision, audition, touch, taste, and smell. Psychological dimensions of such process leading to consideration of perception as characteristic of organisms. Prerequisite: Psych 1. Shortess

374. Sensation and Perception Laboratory (1) NS spring
Laboratory exercise applying quantitative methods of the study of sensory processes. Prerequisites: Psych 114; Psych 373, previously or concurrently. Shortess

375. (Biol 375) Physiological Psychology (3) NS fall
The physiological basis of behavior, both human and animal. Particular emphasis is placed on the neural mechanisms involved. Prerequisites: Psych 1; eight semester hours of physics, chemistry or biology. Nyby, Shortess

376. Physiological Psychology Laboratory (1) NS fall
A survey of techniques in physiological psychology. Prerequisite: Psych 375, previously or concurrently. Nyby, Shortess

382. (Bio 376) Biopsychology (3) NS spring
Human and animal behavior from a genetic, evolutionary, and physiological perspective. Emphasis on techniques used in assessing the role of genes, environment, and evolution. Prerequisite: Psych 1 or Biol 21 or Anthro 12. Nyby

385. Programming Applications to Psychological Instrumentation (3) NS spring
The computer in the psychological laboratory: PASCAL on the Apple computer; real-time acquisition of data; computer control of experiments. Prerequisite: CIS 11 or CIS 17. Kay

For Graduate Students

The department of psychology offers doctor of philosophy (Ph.D.) and doctor of arts (D.A.) degrees in general experimental psychology (e.g., learning, physiological, cognitive, developmental, personality, perception). Empirical research and college teaching of psychology are integral parts of both programs. The doctor of arts is identical to the doctor of philosophy except that greater flexibility is allowed in the doctoral project. The doctorof philosophy program, with its greater research emphasis, is more appropriate for university teaching or other positions involving basic or applied research. The D.A. is designed to prepare teachers of psychology for positions in two- and four-year colleges or community colleges.

Requirements for a doctoral degree at Lehigh. The Graduate School requires ninety credit hours for a doctoral degree for those entering with a bachelor of arts or bachelor of science degree; sixty credit hours are required for those entering with the master of arts or master of science. All doctoral candidates are required to spend at least one year in residence, i.e., in full-time work toward the degree.

Required departmental courses. The department requires the following:

Psych 421 and 422, Analysis and Design of Experiments. These courses represent a two-semester sequence of theoretical and applied statistics and research methodology.

Psych 409, Teaching Seminar. A one-credit discussion group often integrated with current graduate student teaching experiences; required for four semesters.

Psych 463, College Teaching of Psychology. This course covers philosophical and practical issues related to the teaching of psychology.

Psych 400+, Graduate Seminars. During the first four years of study, all graduate students must take at least six graduate seminars approved by the faculty. The faculty designates one approved seminar each semester.

Outside minor. The outside minor consists of twelve credit hours taken outside the department (e.g., biology, education, philosophy, anthropology, sociology, mathematics) and approved by the student's doctoral committee as being well integrated with the student's graduate program.

Research. All graduate students are encouraged to be involved in research throughout their graduate careers. All first year students are required to complete three credits of Psych 461, Research Seminar, as well as to make one research-related colloquium/presentation to the department.

Computer programming and applications. In the spring semester of the second year, all students are required to take Psych 385, Programming Applications to Psychological Instrumentation. This course covers use of the Apple computer in the psychological laboratory, and has as a prerequisite knowledge of PASCAL (CIS 11, CIS 17, or equivalent). In addition, some brief computer seminars will be assigned (to be announced in Psych 409).

Master's thesis. An empirical (data-based) master's thesis is required. Students entering with a master's degree may submit their thesis in fulfillment of the departmental thesis requirement. If the faculty does not feel that the thesis meets the departmental research requirement, the student may be asked to do a research project at Lehigh, equivalent in scope and quality to what is required in a master's thesis at Lehigh.

Doctoral dissertation. This is an original piece of scholarly work. For the doctor of philosophy, this is usually empirical research, although original theoretical or historical research is possible with faculty approval.

Doctor of arts project. The doctoral project is usually directly concerned with college teaching.

All thesis and dissertation topics must be approved by the student's thesis or doctoral committee. The student should form these committees prior to preparation of the thesis or dissertation proposal. Note: The Graduate School requires an oral dissertation defense and the department also requires an oral presentation of the master's thesis. These oral presentations must be scheduled to leave enough time to modify the final written dissertation or thesis depending on issues that may develop during the oral presentation. The department also requires that at least one approved copy of the dissertation or thesis be made available in the psychology office at least two weeks prior to the scheduled oral. Dissertation or thesis committee approval is required before the oral presentation may be scheduled.

Teaching. All graduate students are encouraged to participate in teaching as appropriate for their training throughout their graduate years. Normally, students begin as teaching assistants in faculty-taught courses, and progress to team teaching, teaching recitation sections, and teaching independently.

Psych 465, Teaching Internship, involves teaching a course with faculty supervision and follows completion of the master's degree (including an approved thesis). This course may be followed by the teaching of regularly offered courses and/or student-proposed courses with less faculty supervision. Courses at some area colleges are also available for graduate student teaching. All graduate student teaching requires faculty approval.

Evaluation. Graduate students are evaluated on their performance in course work, research, teaching, assistantship assignments, and the qualifying and general examinations described below. Following the end of each semester, the faculty provides each student with a written evaluation of progress in the graduate program. For both the qualifying and general examinations, all faculty participate in writing questions and grading answers in their areas of competence.

Qualifying examination. This is required for master's and doctoral candidacy, and is a one-day, in-class written examination in general psychology. First-year students are given a set of questions with the examination consisting of a subset of these questions. The examination is given at the beginning of the third semester (i.e., first semester, second year). If the examination is not passed at the doctoral level, the faculty may require: a reexamination; removal from the graduate program; removal following a terminal master's degree; remedial work in selected areas; or some other option. Acceptance into master's or doctoral candidacy is decided not only by the quality of performance on the qualifying examination, but also by the faculty evaluation of all aspects of the student's performance.

General Examination. This is required for all doctoral candidates and must be passed at least seven months prior to the awarding of the degree. The student may opt for a major/minor or a major only exam; subareas to be covered on the exam are selected by the student in consultation with the student's general exam committee. The student may opt for an in-class exam (one-day, closed book) or a take-home exam (seven-days, open-book, answers typed). An oral examination follows faculty evaluation of the written exam.

How to apply. Applications for admission and financial aid may be obtained from the department of psychology. Completed application forms plus transcripts, letters of recommendation, and a report of scores on the Graduate Record Examination aptitude tests and advanced tests in psychology should be returned to the office of admission not later than February 1 of the year of admission.

Normally, new students are accepted for entrance into the program only for the fall semester. Financial support is available in the form of teaching and research assistantships, fellowships, and scholarships. There are special fellowships for minority students. While a good undergraduate background in psychology is desirable, promising students with majors other than psychology are encouraged to apply.

Research interests. The current faculty describe their research and scholarly interests as follows: Arthur Brody, animal psychophysics, operant conditioning and behavior modification; Maureen Callanan, cognitive development, language acquisition, conceptual organization and development; Donald Campbell, research design in field situations, social and biological evolution as they relate to human behaviors; Joyce Clark, teaching-learning process, sex-role attitudes and interpersonal relationships; Lawrence Fehr, personality assessment, development of perspective-taking skills, guilt; Richard High, history and philosophy of psychology, role of organization and stereotypes in remembering; Diane Hyland, personality development in adulthood, influence of stereotypes on memory; Edwin Kay, statistics and mathematical psychology, learned helplessness and animal psychophysics; William Newman, somatic approaches to personality (tai chi and rolfing), humanistic therapy, psychophysiology and self-control; John Nyby, physiological and comparative psychology, behavioral genetics, sociobiology, auditory and chemical communication in mice; Martin Richter, discrimination learning, evaluation of teaching and classroom learning, experimental methodology and statistics; George Shortess, physiological psychology, visual perception, experimental aesthetics.

Graduate-Level Courses

402. (HD 402) Behavior Modification (3)
Theory and applications of behavior modification methods in classroom and clinical settings. Methods derived from operant, classical, and cognitive models. Topics include behavior analysis, charting behaviors, outcome research, and ethical and philosophical issues. Prerequisite: HD 400 or its equivalent.

409. Teaching Seminar (1) fall-spring
One-hour meeting per week of first- and second-year graduate students to discuss topics of concern to teachers. May be repeated for credit.

411. Interpersonal Awareness (3)
Designed to improve awareness of personal functioning and to enhance interpersonal perception and communication. Application to problems of teaching and learning. Prerequisite: consent of the department chairperson. May be repeated for credit. Newman, Clark

421. Analysis and Design of Experiments (3) fall
First of a two-semester sequence covering a variety of issues in theoretical and applied statistics with emphasis on inferential statistics and analysis of variance. Kay, Richter

422. Analysis and Design of Experiments (3) spring
Continuation of Psych 421. Prerequisite: Psych 421. Kay, Richter

434. Special Topics in Personality (3)
Selected topics in personality theory and research, including but not limited to personal change, ego psychology, and psychology of women. May be repeated for credit.

438. Special Topics in the History of Psychology (3)
Contemporary historiography of psychology; methods of historiography, with special reference to quantitive and archival research; roots of experimental psychology in experimental physiology, history of Russian and Soviet psychology; history of research on visual functions. May be repeated for credit.

441. Communicating Psychological Concepts (3)
How to organize facts and ideas into broader meaningful units that are readily communicable. Includes media aids and the structure experience as a communication aid. Prerequisite: consent of the department chairperson. Newman

448. (CIS 402) Seminar in Psycholinguistics (3)
Selected topics in psycholinguistics examined in depth and in detail. Prerequisite: CIS 302. Rubenstein

450. Special Topics in Mathematical Models and Statistics (3)
Selected topics in the application of mathematics to psychological theory and the application of statistics to psychological research. May be repeated for credit. Brody, Kay, Richter

453. Advanced Topics in Learning (3)
An intensive study with emphasis on current research of discrimination learning, avoidance learning, concept learning, problem solving, or verbal learning. May be repeated for credit. Brody, Richter

460. Special Study (1-3) fall-spring
Study of some special topic not covered in the regular course offerings. May be repeated for credit.

461. Research Seminar (1-3) fall-spring
Original research projects not connected with master's or doctoral theses are designed and executed in collaboration with the faculty. Students meet with the seminar director to critique each other's projects.

463. College Teaching of Psychology (3)
Consideration of problems in the preparation and presentation of college courses in psychology; ancillary problems associated with the profession of psychology; practice in teaching. May be repeated for credit.

464. Projects in Research (3) spring
One or more research projects carried out in apprenticeship with a faculty member; course concludes with written and oral reports based on these projects.

465. Teaching Internship (3-6) fall-spring
The preparation, teaching and grading of one or two undergraduate courses with appropriate supervision by members of the faculty. Observation and evaluation of the intern via classroom visits and videotapes. May be repeated for credit.

471. Applied Psychology Internship (1-6) fall-spring
Supervised, independent field work experience in e.g., industry, a medical setting, or a mental health setting. May be repeated for up to six hours credit.

472. Special Topics in Physiological Psychology (3)
Selected topics from sensory psychophysiology, drive, short-term memory mechanisms, bioelectrics, etc. May be repeated for credit. Nyby, Shortess

473. (HD 473) Personality and Adjustment (3)
Theories of personality and adjustment with emphasis on the adjustment processes in an educational setting. Prerequisite: consent of the program director. Fehr, Hyland

474. (HD 474) Special Topics in Developmental Psychology (3)
Topics selected from such areas as socialization and the parent-child interaction, personality disorders in childhood, moral development and cognitive development. May be repeated for credit. Callanan, Fehr, Hyland

475. (HD 475) Theories of Psychological Counseling (3)
Analysis and synthesis of concepts drawn from counseling theorists. Research and current trends in counseling concerning educational, social and vocational problems. Prerequisite: admission to program in counseling.

476. Special Topics in Cognition (3)
Selected topics in human information processing including perception, attention, memory, thinking, and decision making. Callanan, High, Richter

Religion Studies

Professor. Hubert L. Flesher, M.A.
Associate professor. Norman J. Girardot, Ph.D. (on leave 1983).
Assistant professors. Alice L. Eckardt, M.A.; James J. Reid, Ph.D.; David Schenck, Ph.D., *acting chairperson* (1983); Lydia A. Speller, D.Phil.

Religion studies is committed to the academic investigation of religion as an intrinsic and vital dimension of human culture. The scholarly study of religion is an integral facet of liberal education. The student of religion is engaged in the critical and interpretive task of understanding patterns of religious thought and behavior as aspects of the human cultural experience.

Religion studies is interdisciplinary in that it draws

upon humanistic (involving historical and philosophical perspectives) and social scientific (involving sociological, anthropological, and psychological perspectives) modes of inquiry. Religion studies is a cross-cultural, comparative discipline concerned with the character and significance of the major religious traditions of the world. The student of religion confronts ethical problems and foundational issues of value and meaning raised by modern pluralistic and technological society.

Program of Study

Courses in the department of religion studies reflect the interdisciplinary and cross-cultural nature of the field. The various offerings in the department focus on are focused in three interrelated areas.

Historical courses stress the nature and development of particular religious traditions from both the East and the West—e.g. Judaism and Hebrew Scriptures; New Testament, The Catholic Tradition and The Protestant Tradition; The Islamic Tradition; Religions of India and Religions of China.

Comparative and thematic courses concentrate on special historical or methodological topics related to the general cultural significance of religion—e.g. Religions of the World, The Jewish-Christian Encounter, Women and Religion, Islam In the Modern World.

Analytical courses are concerned with the significance and meaning of religion in the contemporary secular and technological world (involving philosophical, ethical, theological, sociopolitical, and aesthetic questions)—e.g. Science, Technology and the Religious Imagination; Religion and the Arts; Contemporary Theology; The Professions, Ethics, and the Religious Life; and Myth and Meaning in Religion.

Opportunities in the Study of Religion

Students are encouraged to enroll in any course offered by the department, either as general electives or in a major/minor program. The interdisciplinary character of religion studies makes the pursuit of a major/minor concentration in relation with other fields especially appropriate. Religion studies may be combined with other fields as part of a joint major, double major, or minor program.

A major or minor program linked to other humanistic or social scientific fields is therefore both recommended and invited. Lehigh students have, for example, combined a religion studies major not only with traditional humanistic disciplines but also with such diverse fields as mechanical engineering, electrical engineering, economics, biology, mathematical physics, social relations, international relations, and psychology. Special programs of study can be tailored to the specific needs and interests of the student.

Since religion studies addresses fundamental questions of personal value and social concern, students have found a concentration in the study of religion a stimulating complement to pre-professional programs in law, medicine, business, foreign careers, and journalism. The study of religion is especially applicable to vocations in teaching, ministry, counseling, social work, religious journalism, and publishing.

Some background and training in religion studies is most of all an excellent preparation for careers where a broad liberal education, cross-cultural awareness, critical modes of thought, and a concern for human values are important.

Major in Religion Studies

Students are particularly encouraged to consider a joint or double major with another major field from any of the three colleges at the university. RS 11 is the foundational course for the religion studies major. Ordinarily, nine additional courses (for a total of 30 credit hours) in the department are selected in consultation with the major advisor. Majors should concentrate in one of the three areas described above or in one religious tradition (i.e. Western or Eastern religions) and also take at least three courses (9 credit hours) outside that area or tradition.

Religion studies majors are encouraged to supplement their studies through related course offerings in such interdisciplinary programs as the Jewish Studies program (see p 39), the East Asian Studies program (see p 38), and the Science, Technology, and Society program (see p 218). Those who plan to pursue graduate work are advised to study a foreign language or languages related to their area of concentration (i.e. Hebrew, Greek, and Latin for Western traditions and Chinese for Eastern traditions). With sufficient student demand, the department offers for credit instruction in Biblical Hebrew, New Testament Greek, Classical Persian, and Classical Chinese.

Minor in religion studies. Normally a minor consists of RS 11 plus a minimum of four other courses for a total of 15 credit hours, chosen in consultation with the minor advisor.

Recommended preliminary distribution courses. Any religion studies course may be taken to meet the Humanities distribution requirement. Freshmen may enroll in any 100-level religion studies course with the consent of the instructor. Religion studies courses such as RS 107, 109, 111, 114, 115 qualify for the Foreign Culture distribution requirement (consult updated distribution requirement lists for other religion studies courses fulfilling the Foreign Culture option).

Recommended upperclass distribution courses. Any course at the 100 level or above may be taken.

Courses of Study

11. Religions of the World (3) fall, spring
The world's major religious traditions: Judaism, Christianity, Islam, Hinduism, Buddhism, and Chinese and Japanese religions. Girardot, Schenck

15. Ethics in the Religions of the World (3)
Relationship of ethics to various religious traditions. Responses of religious traditions to basic ethical questions. Schenck

51. Tribal Religions (3)
Comparative introduction to the religious traditions of nonliterate peoples; emphasis on North American Indian, African and Australian traditions. Symbol, myth, ritual and shamanism in relation to culture and history. Girardot

53. (Hist 53) Religion and the American Experience (3)
The historic development of major American religious groups from colonial times to the present. Their place in social and political life, and the impact of the national experience upon them. Emphasis on religious freedom and pluralism, and the church-state relationship. Eckardt

101. Judaism (3)
The rise, development and teachings of the Jewish religion. Emphasis on the encounter of Judaism and the Jewish people with other cultures and faiths, and on theology rooted in historical events. The holy days and their significance. Eckhardt

103. The Catholic Tradition (3) fall
Historical and theological investigations of Orthodox and Roman Catholic traditions. Issues of doctrine, authority, community and liturgy. Speller

105. The Protestant Tradition (3) spring
Origin and development of the major forms of Protestant Christianity. Interactions with Catholic traditions. Issues of faith, reason and religion, scriptural authority. Speller

107. The Islamic Tradition (3) fall
Origin and development of classical Islam. Topics

include Muhammad and the Koran; legal, theological, and ritual institutions; the Caliphate; Islamic mysticism; Islamic cosmology and Islamic science. Reid

109. Islam in the Modern World (3) spring
Islamic world during the nineteenth and twentieth centuries. Islamic responses to colonialism and modernization. Islamic movements in North Africa, Arabian Peninsula, Central Asia, Iran, India, and the Arab world. Reid

111. The Hebrew Bible/Old Testament (3) fall
Theological examination of a major portion of the Hebrew scriptures, with emphasis upon literary, historical and critical problems. The near Eastern context of Hebraic religious development; the Exodus tradition and the Patriarchal Period; the conquest of the land; the development and dissolution of the monarchy; the prophetic movement. Flesher

114. New Testament (3) spring
Study of early Christianity, with emphasis upon early Apostolic writings. The Synoptic Gospels; the Fourth Gospel; Paul's writing; the later Epistles; the Apostolic Fathers; the development of Gnosticism; parallel Hellenistic religions; newly discovered secret gospels from the second century. Flesher

115. Religions of China (3) fall
History and meaning of the major forms of Chinese religion—especially Confucianism and Neo-Confucianism, Taoist mysticism, Buddhism (Ch'an/Zen), and popular religion. Girardot

119. Religions of India (3) spring
Origin, development and meaning of the major forms of Indian religious traditions. Attention to elite and popular forms of Hinduism, Yoga, early Buddhism. Girardot

123. Critics of Religion (3)
Eighteenth through twentieth century criticisms of religion found in such thinkers as Voltaire, Marx, Freud. Detailed textual analysis; lectures and discussion. Schenck

124. (Phil 124) Reason and Religious Experience (3)
A critical look, from a philosophical perspective, at some fundamental problems of religion: The nature of religious experience and belief, reason and revelation, the existence and nature of God, the problem of evil, and religious truth. Hare, Schenck

133. Science, Technology, and the Religious Imagination (3)
Impact of the scientific and technological culture on the Western religious imagination. Roots of science and technology in religious ideas and images. Readings in the works of Weber, Tillich and Berger. Schenck

134. The Professions, Ethics, and the Religious Life (3)
Interrelationship of the practice of a profession and the practice of religion. Ethical issues in professions —medicine, law, business, education, engineering—and the effects of professionalization on religious life. Schenck

135. Myth and Meaning in Religion (3)
Inquiry into the meaning of religious symbols, myths and rituals. Historical perspectives; philosophical and methodological problems. Readings in the works of Otto, Cassirer, Eliade, and Levi-Strauss. Girardot, Schenck

143. (Phil 143) Kierkegaard (1)
An introduction to the life and thought of Kierkegaard, the nineteenth century Danish forerunner of existentialism, with a brief look at his impact on philosophy, theology, psychology, and literature. Melchert

151. The Jewish-Christian Encounter (3)
Historical analysis of relations between Jewish and Christian communities. Attention to doctrinal and liturgical similarities and differences. Special emphasis on the twentieth century. Eckardt

153. Women and Religion (3)
The images and roles of women within varied religious traditions, and their impact on attitudes and social structures, especially in the West. Such specific issues as goddesses and witches, woman as holy virgin and temptress, religious aspects of the feminist movements, and religion as repressive and liberating. Contemporary movements for change. Eckardt, Speller

154. (Hist 154) The Holocaust: History and Meaning (3)
The Nazi holocaust in its historical, political and religious setting. Emphasis upon moral, cultural and theological issues raised by the Holocaust. Eckardt

157. (Hist 157) The Renaissance and Reformation (3)
The transition from medieval to modern society. Consideration of political, economic, and social forces produced by the Renaissance and their influence upon the dominant religious theme of the Reformation era. Baylor

163. Contemporary Theology (3)
Major twentieth century movements within Christian and Jewish theology understood as responses to the problems of modern times. Flesher, Speller

171. Religion and the Arts (3)
Examination of religious themes in such areas as literature, film and painting, with shifting content from term to term. Alternate fields of study include world literature, modern prose works, the contemporary American novel, and science fiction and fantasy. Flesher, Schenck

241. (Clss 241) Paganism and Christianity (3)
Religious groups in the Roman Empire as social phenomena. Reactions to historic circumstances. Similarity and divergence of religious experience. Readings in primary sources. Lectures and discussion. Phillips

251. (Clss 251) Classical Mythology (3) spring
Myth, religion and ritual in ancient Greece and Rome. Emphasis on primary sources; introduction to ancient and modern theories of myth. Cross-cultural material. Phillips

271. Special Topics (1-3)
Intensive study in areas appropriate to the interests and needs of students and staff.

300. Apprentice Teaching in Religion Studies (1-3)

335. (SR 335) Religion, Symbolism and Cosmology (3)
How human experience is mediated through the use of symbols. Religious and cosmological systems in cross-cultural perspective. Frankel, Gatewood

355. (Hist 355) European Intellectual History (3)
Political and religious thought and other aspects of the history of ideas in Europe from the Middle Ages to about 1700. Baylor

Russian and Russian Area Studies

See listings under Modern Foreign Languages and Foreign Careers.

Science, Technology And Society

Steven Louis Goldman, Ph.D., Andrew W. Mellon Professor in the Humanities, *program director.*

The Science, Technology and Society (STS) program is the product of a continuing intercollege effort to create a common ground from which to explore the relations between science, technology and society: between ideas, machines and values.

The STS program promotes the development of undergraduate courses that analyze the social and personal implications of science and technology and that study the natures of both from the perspective of the human subjects engaged in these activities. Its most basic commitment is to the view that science and engineering are cultural phenomena and hence essentially human enterprises.

STS serves as a focal point for a wide range of courses—from music and art to philosophy to physics and metallurgy—in many departments that treat one or another facet of these themes, lending coherence and visibility to offerings otherwise dispersed throughout the catalog.

The program also offers a minor in Technology and Human Values, open to all undergraduates, for which students take a set of courses drawn together by their common STS focus and consisting of at least eighteen credit hours of work, with two required courses and four electives. The student takes STS 11 or STS 113 and a course in the history of technology, such as Hist 7 or Clss 108. The elective courses, spread over the various fields in the humanities and social sciences, are chosen with the advice of the director of the program in consultation with the student.

Science, Technology and Society Courses

11. Technology and Human Values (3) fall
Impact of technology on society in relation to ethical problems raised by the exploitation of technological innovations. Illustrations from literature, art, philosophy, history, folklore, and film.

113. Science and Human Values (3) spring
Investigation of the relationship between theories of nature and theories of man. Classical, modern, and contemporary scientific interpretations of nature examined for the interpretations of man embedded in them.

181. Independent Study fall-spring
Prerequisite: consent of the program director.

Other STS courses. The following special courses are offered by various departments. Descriptions may be found under the entry for the individual department.

Anthro 131	Science, Technology and Society
Anthro 151	Utopias and Alternative Communities
Arch 209	Architecture, 1750-1880
Arch 210	20th-Century Architecture
Arch 251	History of Urban Design
CIS 202	Computers and Society
Clss 108	Ancient Technology
Clss 204	Ancient City and Society
Eco 311	Environmental Economics
Eco 314	Energy Economics
Engl 89	Science Fiction
Engl/Phil 150	Media and Values
Engl 187	Utopia: Fantasy or Reality
Gov 357	Technology Assessment
Hist 7	Machine in America
Hist 8	History of Medicine in America
Hist 207	Seminar in the History of Technology
Hist 337	History of Medical Thought
Hist 339	Topics in American Public Health
Hist 340	Topics in American Medicine
IR 41	Science, Technology & International Relations
IR 80	Politics of Oil
Journ 123	Basic Science Writing
Journ 125	Environment, Public, and Mass Media
Journ 126	Public Relations
Journ 311	Science Writing
Journ 312	Advanced Science Writing
Journ 313	Special Topics in Science Writing
Mus 153	Electronic Music
Phil/Psych 75	Behavior Control and Human Values
Phil 100	Philosophy of Contemporary Civilization
Phil 115	Business Ethics
Phil 116	Medical Ethics
Phil 128	Philosophy of Science
Phil 161	Science, Philosophy and Religion
Phil 250	Minds of Men and Robots
Phil 260	Philosophy of the Social Sciences
RS 133	Science, Technology & The Religious Imagination
RS 134	The Professions, Ethics, & The Religious Life
Soc 361	Sociology of Medicine and Health
STS/Hist 145	Introduction to the History of Science
STS/Journ 124	Politics of Science
STS/Met 221	Materials and the Development of Man
Thtr 161	Theater Design and Technology

The program is constantly developing new courses. Bulletins announcing and describing them are published regularly. For further information, consult the director.

Social Psychology

See listings under Social Relations.

Social Relations

Professors. Donald T. Campbell, Ph.D., University Professor of Social Relations and Psychology; Roy C. Herrenkohl, Ph.D.; Robert C. Williamson, Ph.D.
Associate professors. Barbara B. Frankel, Ph.D.; James R. McIntosh, Ph.D., *chairperson;* Robert E. Rosenwein, Ph.D.
Assistant professors. Thomas O. Blank, Ph.D.; John B. Gatewood, Ph.D.; Judith N. Lasker, Ph.D.

Social relations, broadly conceived, is the study of human beings in relationships with others. As such, it encompasses the study of the broadest range of human social activities from the comparative examination of widely divergent cultures and societies to the inner life of the individual as this influences social behavior.

The three disciplines represented in this

department—anthropology, sociology and social psychology—have as their goal to foster both self-awareness and societal awareness by providing students with the knowledge and analytic skills necessary to the accomplishment of these aims. The disciplines represented in the program provide a student with a clearer understanding of self. To study social relations is to develop a sense of the influences that have shaped one's past and pattern one's future.

But self-awareness is only a beginning. Human behavior occurs within diverse settings, groups and other collectivities. Coping with and resolving conflict, reducing strain and tension, and managing and building cooperation are central themes of study in departmental courses. Whether in the study of primitive kinship systems, the messages of nonverbal behavior, or the elements of wealth and power, one comes closer to an understanding of social life in organizations, organizational behavior and the structure of groups and societies.

Research Opportunities

It is the explicit aim of the social relations department to involve majors, minors and other interested students in the ongoing research activities of faculty members. A list of current research programs and research assistant opportunities is maintained in the departmental office in Price Hall.

Second-semester sophomore, junior and senior students interested in a supervised research experience are invited and encouraged to consult the list and talk with the appropriate faculty member. Course credit may be received for research experience.

Fieldwork in Social Relations

The department maintains close, working relationships with a variety of social agencies and institutions in the area. Students may earn course credit by carrying out supervised work in field settings, e.g., hospitals, private and public agencies devoted to social services, courtrooms, prisons, etc. This useful experience allows a student to apply the concepts learned in the classroom to a field setting and to evaluate vocational aspirations and interests.

Students interested in social work may take courses in the Social Work Education Program, an undertaking of the Lehigh Valley Association of Independent Colleges. For further information, contact Robert C. Williamson in the social relations department.

Social Relations and Careers

Social relations majors are found in business, industry, government, the service areas, and the academic world. Some Lehigh students have gone on to earn the master's degree or the doctor of philosophy. Many have sought professional degrees. For example, training in the social sciences is excellent preparation for law school or seminary programs. Most students go from the university directly to work. Graduates are planners, administrators, case-workers, interviewers, personnel officers, health and welfare workers, sales representatives, consultants, researchers, media managers, owners of their own business, as well as career military people.

A major in social relations provides a strong core around which students can develop career-based programs of study.

For example, a person interested in public health would add courses in biology, management and psychology to the requirements for the social relations major. Someone interested in personnel work might take courses in psychology, management, and marketing. A prospective law student might elect the Law and Legal Institutions minor in addition to the social relations major. A student who is interested in a career in the social services or the helping professions might elect a double major in social relations and psychology or an interdisciplinary major in those two fields.

Of particular interest to those students in a career in business administration is the bachelor of arts-master of business administration degree (Arts B.A.-M.B.A.). In this option, a student would major in social relations, take requisite courses in the College of Business and Economics, and then take additional study in business administration beyond the bachelor of arts degree. This program is described in more detail in the College of Arts and Science entry, Section III.

A list of updated university courses specific to these options is on file in the departmental office. There are, of course, many other career possibilities. Students interested in formulating a particular career-based program of study should consult the department chairperson, who serves as department career adviser.

Major Requirements in Social Relations

A major in social relations consists of 36 hours of course work. This total includes 15 credits of core courses (6 in introductory level courses and 9 in theory and methodology) and 21 hours of electives. Students are required to have a minimum of 6 hours from each discipline. A student may concentrate in any one discipline by taking 12 elective credits in anthropology, social psychology, or sociology.

Core Courses (15)

Introductory (6)

Anth 11	Sociocultural Anthropology (3) *or*
Anth 12	Emergence of Mankind and Culture (3)
Soc Psych 21	Social Psychology
Soc 5	Introductory Sociology

Theory and Methodology (9)

SR 111	Integrated Study of Social Relations (3)
SR 377	Computer Applications in Social Relations (3)
SR 381	Development of Social Theory (3)
Elective	(21 hours)

Requirements for the Minor

Social relations: One introductory course, SR 111 and nine additional credits at the 100 level or above, three hours from each discipline.
Anthropology: Anth 11 or 12, SR 111 and nine additional credits at the 100 level or above in anthropology.
Social Psychology: Soc Psych 21, SR 111 and nine additional credits at the 100 level or above in social psychology.
Sociology: Soc 5, SR 111 and nine additional credits at the 100 level or above in sociology.
Interpersonal Behavior in Small Groups and Organizations: See description under Special Opportunities, page

Honors Option

A student may be graduated with honors by completing an independent project supervised by one or more members of the faculty. Students who elect this option will be required to take a readings course (SR 371 or 372) and SR 399 (senior project).

Students who intend to go on to graduate school should particularly consider electing the honors option. The department chairperson should be consulted for further details.

Undergraduate Courses
Social Relations

41. Human Sexuality (3)
Analysis of the socialization of sex roles and the life cycle,

premarital and marital sex behavior, human reproduction and its control. Some attention to deviant sex roles. Williamson

111. Integrated Study of Social Relations (3) fall
Theory and methodology in analyses of social relations. Use of contemporary journals and other materials providing an introduction to requisite skills in anthropology, sociology and social psychology.

112. Integrated Study of Social Relations (3) spring
Continuation of SR 111. Prerequisite: SR 111.

171. Seminar in Social Relations (3)
Topics in social relations, anthropology, sociology, and social psychology. Topics vary. May be repeated for credit.

343. (Psych 343) Scientific Method for Applied Social Sciences (3)
Problems in the application of scientific methods in policy-relevant research. Prerequisite: introductory statistics or consent of the chairperson. Campbell

345. (Psych 345) Seminar on the Social Evolution of Complex Organizations (3)
May be taken more than once. Possible topics: Evolution of archaic city states. Role of theism and theocracy. Moral norms as socially evolved curbs to the dysfunctional species-personality produced by biological evolution. Parallel problems in modern bureaucracy. Campbell

347. (Psych 347) Seminar on Sociology and Psychology of Science (3)
Specific topic varies from year to year. May be taken more than once. General focus is on those sociological and psychological processes in science that are relevant to the credibility of a science's claim to be improving its validity. Campbell

363. Seminar in Social Relations (1-4)
Selected social science topics.

365. Fieldwork in Social Relations (1-3)
Supervised work experience and observation in a variety of field settings, e.g., hospitals, social services, public agencies, private organizations. Prerequisite: consent of chairperson. Lasker, Rosenwein

368. The Urban Community (3) spring
A study of urban communities in the world and the United States. Theories of urban life and the special qualities of urban interaction. McIntosh or Frankel

371. Special Topics in Social Relations (1-3)
An opportunity for advanced work through supervised reading and research. Prerequisite: consent of the department chairperson.

372. Special Topics in Social Relations (1-3)
Continuation of SR 371.

377. Computer Applications in Social Relations (3)
Computer applications in the social and behavioral sciences. Use of statistical programs such as SPSS and data management systems such as SIR.

381. Development of Social Theory (3)
Comparative study of social theory.

393-394. Independent Research (3-4)
Students will conduct research under faculty supervision. Prerequisite: consent of the department chairperson.

395. Methods in Observation (3) alternate years
Naturalistic and participant observation in uncontrolled field settings. Frankel or Rosenwein

399. Senior Project (3)
Independent work fulfilling honor requirements. Prerequisite: SR 111 or 112, or consent of the department chairperson.

Anthropology

11. Sociocultural Anthropology (3)
Human behavior in cross-cultural perspective. Variations in kinship reckoning, political organization, economic and religious life in comparative perspective. Particular non-Western peoples: films and readings.

12. Emergence of Mankind and Culture (3) NS
Introductory biological anthropology and prehistory. Adaptive function of human culture and its relation to biological evolution. Hominid fossil record, nonhuman primate social behavior, cultural beginnings, and survey of world prehistory. Gatewood

131. Science, Technology and Society (3)
Relationships of science and technology to social life across time and space, with alternative theoretical models for understanding these relationships. Frankel

133. Cultural Passages (3)
Study of literary materials—novels, travelers' accounts, and ethnographers' fieldwork experiences—to see the role of human nature in transcending cultural differences. Rites of passage within one culture. Gatewood

151. Utopias and Alternative Communities (3)
Present and past searches for new forms of community in fact and fiction. Frankel

182. North American Indians (3)
Culture areas of native North America prior to substantial disruption by European influences north of Mexico. Environmental factors and cultural forms. Gatewood

184. Cultures of the Pacific (3)
Cultures of the Pacific Islands: langauage families, prehistories, and social organizations. Focus: Melanesian cultures. Gatewood

321. Anthropology of Physical and Mental Health (3)
Definition and treatment of physical and mental health in cross-cultural perspective. Strategies for coping with illness in literate and nonliterate, Western and non-Western societies. Frankel

335. (RS 335) Religion, Symbolism and Cosmology (3)
How human experience is mediated through the use of symbols. Religious and cosmological systems in cross-cultural perspective. Frankel

339. Seminar in Anthropology (3)
Topics in anthropology. Varying from semester to semester: human evolution, politics and law, introduction to linguistics, human use of space, anthropology of deviance. May be repeated for credit. Frankel, Gatewood

363. Kinship, Marriage and Descent (3)
Kinship as the central institution in primitive social organization. Variations in definition and regulation of marriage and descent in cross-cultural perspectives. Critiques of Murdock, Levi-Strauss, and Fortes. Soc 364 recommended in conjunction with this course. Gatewood

376. Mind, Self and Culture (3)
Concepts and methods of studying relations between the individual and the sociocultural milieu. National character, basic and modal personality structures, cross-cultural studies of cognition, ethnoscience, and ethnosemantics. Soc Psy 135 and 307 recommended in conjunction with this course. Gatewood

Social Psychology

21. (Psych 21) Social Psychology (3)
Theories, methods of investigation, and results of research in social psychology with emphasis on psychological processes in social behavior, social attitudes, group behavior and social interaction.

109. (Psych 109) Adulthood and Aging: Social and Psychological Perspectives (3)
Psychological, sociological and other social science approaches to the latter two-thirds of the life span. Age stratification and distribution patterns, attitudes to aging, social behavior of older adults, widowhood, issues of retirement and use of leisure time. Blank

121. Social Psychology of Small Groups (3)
Study of interpersonal behavior in groups. Survey of relevant theories and empirical research. Rosenwein

135. Human Communication (3)
Processes and functions of human communication in relationships and groups. Rosenwein

175. Competition and Cooperation in Modern Society (3)
Relations between and among social groups, inter-group conflict and cooperation in small and large social groupings. Selected modern examples (e.g., labor disputes, international tensions, inter-generational relations). Blank

307. Attitudes, Attributions, and Actions (3)
Social perception and cognition as studied in current social psychology. Persuasion, conformity, prejudice, stereotypes, and other social processes in relation to attitude formation and change. Anth 376 and Soc Psych 135 recommended in conjunction with this course. Blank

308. Seminar in Social Psychology (3)
Intensive consideration of selected topics in current theory and research in social psychology. The subject matter varies from semester to semester, and includes such topics as the social psychology of education, the applications of perception and learning theory to social psychological problems, the social psychology of science, and the social environment of communication. May be repeated for credit.

312. Interpersonal Behavior in Small Groups (3)
Intensive consideration of theoretical and methodological issues in the analysis of the development of small groups. Rosewein

313. Social Psychology of Education (3)
Effect of value systems, community structures, and social institutions on the educational process. Influence of family dynamics, peer groups, teacher-expectations, and social status in the individual's educational adjustment. Williamson

321. Social Psychology of Developing Adults (3)
Approaches to social and personality aspects of adulthood and aging. Application of a lifespan developmental model and methodology to selected specific issues and current social psychological topics. Prerequisite: one social psychology or psychology course, or consent of the department chairperson. Blank

323. Violence in the Family (3)
Dynamics and consequences of domestic violence: individual, social, and cultural factors. Herrenkohl

325. Organizational Dynamics (3)
Types of leadership, membership, social processes, and tasks which affect accomplishment of organizational goals. Herrenkohl

333. (Govt 333) Social Psychology of Politics (3)
Political behavior viewed from a psychological and social psychological perspective. Rosenwein

391. Evaluation Research (3)
Application of social research methods of evaluation of the effectiveness of social programs. Measurement, research design, criteria of effectiveness and decision making. Prerequisite: SR 111 or 112 or consent of department chairperson. Herrenkohl

392. Social Psychology Research Seminar (3)
Advanced seminar in social psychological research methods: evaluation research and experimental social psychology. Recommended preparation: SR 111 or 112, or Psych 113 and 114, or consent of the department chairperson. May be repeated once for credit.

Sociology

5. Introductory Sociology (3)
Social organization, stability and conflict, structure and function, and processes of social change in society.

53. Popular Culture I (1) first third of semester
Popular music in contemporary society.

55. Popular Culture II (1) second third of semester
Film in contemporary society.

57. Popular Culture III (1) last third of semester
Sports, including the role of play, in contemporary society.

65. Contemporary Social Problems (3)
Studies of major problems facing contemporary society. McIntosh

123. Sociology of Social Welfare (3)
Development of social welfare and human service systems in different societies, especially the United States. Issues in contemporary social welfare policy; specific service institutions (e.g., child welfare and mental health); and the role of social work and other helping professions. Lasker

141. Social Deviance (3)
Analysis of deviant social systems, supporting factors maintaining them, and societal responses to deviant roles and collectivities. McIntosh

151. Wealth, Status and Power in American Society (3)
Theories of the social organization of American society. Sociological impact of education, occupation, and income on social status and social class.

161. Sociology of Occupations (3)
Analysis of occupational choice, recruitment, training and socialization. Attention to the questions of the occupational-professional continuum, the work setting, alienation, the relation of careers to various social organizations, the life cycle and demographic trends. Williamson

167. Change and Conflict in Latin America (3) fall
Introduction to the changing societies of Latin America, including contrasts between urban and rural subcultures. Analysis of ethnic groupings and social institutions, especially family, school and church. Williamson

325. (Hist 325) American Social History, 1607-1877 (3) fall
Social change from early agrarian communities to beginnings of industrialism, emphasizing socio-economic class, family structure, and treatment of women and minority groups.

326. (Hist 326) American Social History Since 1877 (3) spring
Changing role of women, minority groups, and the family during the industrial era. Development of the modern class structure and the impact of the welfare state.

327. Health Policy Analysis (3)
Key issues in health policy: cost containment, quality control, preventive health practices, and distribution of health responses. Roles of government, industry, health professionals, and consumers in policy determination. Lasker

341. Women and Health (3)
Relationships of women to the medical system. Influence of medicine on women's lives and the impact of the women's movement on health care. Lasker

361. Sociology of Medicine and Health (3)
Health, illness, and the health profession from the sociological perspective. Social epidemiology, social psychology of illness, socialization of health professionals, organization of health care, patient-professional relationships and ethical issues in medical care.

364. Lifestyle and the Family (3)
Cross-cultural and historical background of marriage and the family, socialization through the life cycle, dating and mate selection, marital dissolution, and alternate forms of marriage and the family. Anth 363 recommended in conjunction with this course. Williamson

365. Language and Society (3)
The development of language, subcultures, and problems of language maintenance, shift, planning and other aspects of sociolinguistics. Williamson

370. Juvenile Delinquency (3)
The development of delinquent behavior within its social context; an analysis of delinquent gangs and subcultures and the variable patterns of antisocial activity; and the evaluation of institutional controls and treatment of the problem. McIntosh

373. Seminar in Sociology (3)
Intensive consideration of selected topics in contemporary theory or research in sociology. The subject matter varies from semester to semester. May be repeated for credit.

For Graduate Students

The department offers a master's degree program in social relations. This thirty-credit program offers both further preparation for an advanced degree and training for nonacademic careers.

Students may choose to pursue a "health and aging" specialization in our graduate program. After completing the basic theory and methods courses required of all graduate students, the student will take a set of core courses in health and aging and participate in an internship. All graduate students complete the program with a thesis.

Other options that focus on the research interests of specific faculty members are also available. In conjunction with the Center for Social Research the department offers many opportunities for research experience. For further information students should contact the department chairperson.

411. Advanced Research Methods (3) fall
A basic course given in research theory and methods. Consideration given the nature of theory, hypotheses testing, the definition of variables and methods of measurement. Herrenkohl

412. Practicum in Research Methods (3) spring
Laboratory in the design and execution of research. Emphasis on the design of measurement instruments, the application of statistical techniques, and the analysis and interpretation of data. The student pursues an independent research project and writes a research report based on it. Prerequisite: SR 411.

423. Social Psychology (3)
An examination of theory and research in social psychology. The objective of the course is to consider major topics and issues in relation to current research. Rosenwein

431. Social Perspectives on Death and Dying (3)
The meaning of the end of life in various societies, especially the United States. Sociological, anthropological, and psychological perspectives on dying as a process, and on death as an event, combined with philosophical and ethical considerations. Topics to be considered include euthanasia and "extraordinary means" to maintain life from neonate to elderly, funeral practices, stages of dying, hospices, and the social milieu and family relationships of the dying person. Blank

433. Sociology of Aging (3)
The changing roles of the elderly in American and other societies, and the special problems they face. Impact of changing age structure and residential patterns, social policies and services for the aged. Alternative political strategies, health programs, living arrangements and workplace choices considered. Lasker

461. Seminar in Social Relations (1-4)
Topics in social relations: anthropology, sociology and social psychology. Topics vary.

464. Seminar on the Family (3)
Societal functions of marriage and the family and the relation of the institution to the social structure and demographic variables. Particular emphasis on the treatment of family disorganization. Williamson

465. Organizational Behavior (3)
Theory and research concerning the development and functioning of organizations. Structure, goals, authority and power, communication, role conflict in large organizations. Cross-institutional comparisons of industrial research, governmental, medical and academic organizations.

470. Social Theory (3) fall
Major trends in social science theory in historical context. Comparison of the major theoretical perspectives with an emphasis on underlying philosophy and the development of critical capacities in students.

471. Special Topics (1-3)
Intensive study in an area of social relations that is appropriate to the interests and needs of staff and students.

472. Special Topics (1-3)
Continuation of SR 471.

Sociology

See listings under Social Relations.

Spanish

See listings under Modern Foreign Languages.

Theater

See the course descriptions for Speech and Theater.

Speech and Theater

Professors. Thoburn V. Barker, M.A.; Frank S. Hook, Ph.D.
Associate professor. Jeffrey Milet, M.F.A., *head.*
Assistant professors. Bruce Candlish, M.F.A.; Augustine Ripa, M.F.A.; Annie Laurie Wheat, M.F.A.
Adjunct professor. George C. Izenour, D.F.A.

Although theater can be defined in many ways, William Shakespeare perhaps said it best: "All the world's a stage." If we accept his definition, then the study of theater is the study of life.

The bachelor of arts degree is given after a program of study in the traditional theater skills. The major in theater requires a minimum of thirty credit hours. In addition undergraduates participate in all aspects of an active Theater at Lehigh production program. Hands-on involvement is an important part of what we do.

At Lehigh we approach theater with professional discipline. Flexibility is the keynote. Students may participate strictly in extra-curricular activity; they may take courses in acting, directing or design; or they may major in theater or minor in theater or speech. Possibilities also exist for a minor in theater from outside the College of Arts and Science.

The program endeavors to prepare students to apply their talents and training in theater as well as related or associated fields. Students are encouraged to consider a variety of courses outside the major. This reflects our feeling that undergraduate theater education should be broad-based with an emphasis on diverse experience. It is expected that students headed for a career in theater will go on for further work either in a graduate program or professional conservatory.

Working together, students, faculty and visiting professionals prepare productions in the Wilbur Drama Workshop. The Workshop is nondefined experimental space that encourages innovation. In addition, students mount small productions in a lab theater space designed specifically for student experimentation. From time to time Theater at Lehigh presents outside professional groups, adding another dimension to our production program.

An integral part of Theater at Lehigh is our program in theater design and technology research. In this cooperative program with the College of Engineering and Physical Sciences, selected interested students work on ongoing research projects and independent studies projects related to their interests.

Students interested in designing a major or minor program in theater or speech, suitable to their needs, should consult with a member of the division.

Theater Major

Courses required of all majors

Theater 1	Introduction to Theater (3)
Theater 15	Introduction to Technical Theater (3)
Theater 41	Acting I (3)
Theater 71	Introduction to Theater History (3)
Theater 144	Basic Directing (3)

Option I, Acting/Directing

required courses

Theater 113 *or*	Stage Lighting (3)
Theater 115	Scene Design (3)
Theater 121	Acting II (3)
Theater 141	Acting III (3)
Speech 138 *or*	Voice and Articulation (3)
Theater 143	Movement for the Actor (3)
Theater 245	Advanced Directing (3)

Option II, Design/Technical Theater

required courses

Theater 113	Stage Lighting (3)
Theater 115	Scene Design (3)
Theater 116	Advanced Technical Theater (3)
Theater 214	Advanced Lighting (3)
Theater 216	Advanced Scene Design (3)

Option III, Arts/Engineering

Students who elect theater as their arts major in the arts/engineering program are assigned a division adviser who, with the student, defines the major curriculum.

Theater Minors

Acting/directing minor

Theater 1	Introduction to Theater (3)
Theater 15	Introduction to Technical Theater (3)
Theater 41	Acting I (3)
Theater 121	Acting II (3)
Theater 144	Basic Directing (3)

Technical theater minor

Theater 1	Introduction to Theater (3)
Theater 15	Introduction to Technical Theater (3)
Theater 41	Acting I (3)
Theater 113	Stage Lighting (3)
Theater 115	Scene Design (3)

Speech Minor

Speech 30	Fundamentals of Speech (3)
Speech 31	Business and Professional Speaking (3)
Speech 130	Public Speaking (3)
Speech 138	Voice and Articulation (3)

and one of the following for a total of fifteen credit hours:

Speech 133-135	Impromptu Speaking (1)
Speech 137	Oral Interpretation (3)

Course substitutions require consent of the division head.

Undergraduate Courses

Theater 1. Introduction to Theater (3)
Elements of the theatrical experience. The foundations of theater. Examination and discussion of plays.

Theater 15. Introduction to Technical Theater (3)
Stagecraft and drafting for the theater. Concepts in theater technology. Theatrical materials and methods.

Speech 30. Fundamentals of Speech (3)
The basic principles of oral communication.

Speech 31. Business and Professional Speaking (3)
The principles of oral communication as applied to business and professional speaking situations.

Theater 41. Acting I (3)
Introduction to acting. Discussion of text. Basic exercises and technique. Preparation for scene study.

Theater 61. Theater Production I (3)
The role of the production team. Its relationship to the theatrical event. General concepts and techniques applied to actual productions.

Theater 62. Theater Production II (3)
Continuation of Theater 61. Specific skills and materials. Actual production responsibilities. Prerequisite: Theater 61.

Theater 71. Introduction to Theater History (3)
Historical survey of western theater from the Greeks to the twentieth century.

Theater 111. Theater Sound (1)
Techniques, materials, and methods of designing sound for theatrical production.

Theater 113. Stage Lighting (3)
An introduction to the art and practice of lighting for the stage.

Theater 115. Scene Design (3)
An introduction to the art of the scenic designer. History of design for the theater. Materials, methods and techniques.

Theater 116. Advanced Technical Theater (3)
A continuation of Theater 15. Advanced; drafting, problem solving, stagecraft, rigging, materials and techniques. The role of the technical director. Prerequisite: Theater 15.

Theater 121. Acting II (3)
Continuation of Acting I. Knowledge of the physical stage. Scene text, actions, objectives and relationships. Scene study. Prerequisite: Theater 41.

Speech 130. Public Speaking (3)
A continuation of Speech 30. Will emphasize the structure of various types of speeches. Prerequisite: Speech 30.

Speech 133-135. Impromptu Speaking (1)
The organization and presentation of short expository speeches and speeches for special occasions.

Speech 137. Oral Interpretation (3)
The analysis of oral presentation of various types of literature. Sound values, rhythm, imagery, etc.

Speech 138. Voice and Articulation (3)
Voice production and articulation. Recommended for students of acting and those who seek to correct acquired speech patterns.

Theater 141. Acting III (3)
Continuation of Acting II. The actor's techniques. Prerequisite: Theater 121.

Theater 143. Movement for the Actor (3)
Body tone, flexibility, control and agility. Development of center and body areas.

Theater 144. Basic Directing (3)
Introduction to the theatrical director's art. Scene work. Prerequisites: Theater 1 and 41.

Theater 151. Costume Design (3)
The history and development of theatrical costuming. Wardrobe and its relationship to art and culture.

Theater 161. Theater Design and Technology (3)
Theater environments, equipment systems and acoustics. Functions and ethics.

Theater 172. Special Studies in Theater History (3)
Selected periods of theater history. Students work independently on period of their own choice. Prerequisite: Theater 71.

Theater 173. Special Studies in Theater History (3)
Continuation of Theater 172. Prerequisite: Theater 172.

Theater 175. Special Projects (3)
Theatrical topics of current or special interest, e.g., mime. Can be repeated for credit as title varies.

Theater 181. Theater Management (3)
Concepts, techniques and practices related to managing the theatrical enterprise.

Theater 185. Production Seminar (3)
Practicum in various approaches to theater production, e.g. ensemble. Prerequisite: consent of the division head. Can be repeated for credit as title varies.

Theater 214. Advanced Lighting (3)
Continuation of Theater 113. Lighting design for various performance forms. Practical experience. Prerequisite: Theater 113.

Theater 216. Advanced Scene Design (3)
Continuation of Theater 115. Advanced design problems and techniques. Practical experience. Prerequisite: Theater 115.

Theater 243. Acting IV (3)
Continuation of Acting III. The actor's art. Supervised practical experience. Prerequisite: Theater 141.

Theater 245. Advanced Directing (3)
Continuation of Theater 144. Directorial approach. Supervised practical experience. Prerequisite: Theater 144.

Theater 271. Playwriting (3)
Techniques of the dramatist. The playwright's creative process. Practice in creating dramatic forms.

Theater 319. Special Technical Studies (3)
Topics not covered by other courses. Prerequisite: consent of the division head. Can be repeated for credit as title varies.

Theater 351. Advanced Special Projects (1-3)
Independent study in theater. Prerequisite: consent of the division head. Can be repeated for credit as title varies.

Theater 361. Research in Theater Technology (1-3)
Solving technological problems in theater. Application of new technologies. May be repeated for credit. Prerequisite: consent of division head.

Urban Studies

Urban Studies Committee. David Curtis Amidon, Jr., M.A., lecturer in urban studies and *director* of urban studies; Nicholas Adams, Ph.D., assistant professor and chairperson of art and architecture; Carlos J. Alvaré, M.C.P., M. Arch., professor of architecture; Frank T. Colon, Ph.D., professor of government; Paul D. Felder, M. Arch., assistant professor of architecture; James R. McIntosh, Ph.D., associate professor of sociology; Edward P. Morgan, Ph.D., associate professor of government; Warren A. Pillsbury, Ph.D., associate professor of economics; Roger D. Simon, Ph.D., associate professor of history.

This is an interdepartmental major program intended for students who seek a broad background in the social sciences and for those with career interests in such fields as city management, architecture and urban planning, human relations, and the helping professions.

Instruction focuses on the process of urbanization, the problems and opportunities arising therefrom, analytical methods and insights that have been developed by students of urbanization, and existing and proposed public policies relating to cities.

A minimum of 42 credit hours is required, apportioned among three levels of study. Substitutions are possible with approval of the director, who advises all those with majors and minors in urban studies. The director's office is located at 232 Chandler-Ullmann Hall.

Undergraduate Major

I. required preliminary courses (9 credit hours)

US 61	The Study of Urbanization (3)
US 62	Contemporary Urban Issues (3)

one of the following four research methods courses

SR 111	Integrated Study of Social Relations (3)
Govt 21	Introduction to Political Research (3)
Hist 395	Quantitative Methods in Historical Studies (3)
Eco 145	Statistical Methods (3)

II. required core courses (18 or 19 credit hours)
(choice of three of the following five sequences)

economics sequence

Eco 1	Economics (4)
Eco 312	Urban Economics (3)

architecture sequence

Arch 251	History of Urban Design (3)
Arch 252	Physical Planning and Design (3)

government sequence

Govt 77	Urban Politics (3)

and any one of these

Govt 328	Politics of Urban Educational Policy (3)
Govt 331	Internship Seminar (3)
Govt 360	Public Administration (3)

history sequence

Hist 333	American Urban History to 1880 (3)
Hist 334	American Urban History, 1880 to Present (3)

social relations sequence

SR 111	Integrated Study of Social Relations (3) *or*
SR 112	may be substituted if SR 111 has been used to satisfy the research methods preliminary requirement above.
SR 368	The Urban Community (3)

III. area option courses (15 or more credit hours)
One of the following four area options is elected for a minimum of five courses yielding at least fifteen credit hours.

urban management (15 credit hours)
Prerequisites: three core sequences above, including economics and government.

Acctg 108	Fundamentals of Accounting (3)
Eco 337	Transportation and Spatial Economics (3)
Eco 354	Public Finance: State and Local (3)
Govt 331	Internship Seminar (3)
Govt 354	Administrative Law (3)
Govt 360	Public Administration (3)
Law 202	Business Law (3)
Mgt 321	Business and Organizational Behavior (3)
Mgt 270	Organizational Theory and Behavior (3)

urban design (15 credit hours)
Prerequisites: three core sequence above, including architecture and history

Eco 337	Transportation and Spatial Economics (3)
Arch 43	Introduction to Architectural Design (4)
Arch 143	Intermediate Architectural Design I (3)
Arch 243	Intermediate Architectural Design II (3)
Arch 207	Renaissance Architecture (3)
Arch 209	Architecture 1750-1880 (3)
Arch 210	20th-Century Architecture (3)
Geol 211	Environmental Geology (3)
US 363	Philadelphia: Development of a Metropolis (3)

social science (15 credit hours)
Prerequisites: three core sequences above; courses not offered to satisfy the core sequences requirement may be included below.

Eco 311	Environmental Economics (3)
Eco 337	Transportation and Spatial Economics (3)
Eco 354	Public Finance: State and Local (3)
Hist 326	American Social History Since 1877 (3)
Hist 339	Public Health in America (3)
Clss 204	The Ancient City (3)
Anth 151	Utopias and Alternative Communities (3)
Arch 209	Architecture 1750-1880 (3)
Arch 210	20th-Century Architecture (3)
US 363	Philadelphia: Development of a Metropolis (3)
US 365	Lehigh Valley: Development of a Regional Center (3)

or up to two additional US courses (3-6)

human relations (15 credit hours)
Prerequisites: three core sequences above, including social relations. Of the total of fifteen credit hours for this option, at least six hours must be elected from among the courses in each group below:

Cultural groups

US 125	American Ethnic Groups (3)
US 321	White Protestant Americans (3)
US 324	The Irish in American Society (3)
US 326	The American Italian Community (3)
US 328	The American Jewish Community (3)
Engl 312	Jewish Literature (3)
Engl 316	The Indian in American Literature (3)
Engl 319	The Black in American Literature (3)
German 233	Pennsylvania German Culture (3)
RS 151	The Jewish-Christian Encounter (3)
RS 153	Religion and the American Experience (3)
RS 154	The Holocaust (3)
Hist 325	American Social History, 1607-1877 (3)
Hist 326	American Social History, Since 1877 (3)
Hist 131	The Black Experience in America (3)

professional concepts

Govt 328	Politics of Urban Educational Policy (3)
Govt 331	Internship Seminar (3)
Govt 352	Civil Rights (3)
Soc Psy 135	Human Communication (3)
Soc 365	Language and Society (3)
Soc 370	Juvenile Delinquency (3)

Urban studies minor. The minor consists of US 61 and five additional courses from an approved list for a total of eighteen credit hours.

Undergraduate Courses

61. The Study of Urbanization (3) fall
Analyses of the city from early historical speculations to current behavioral studies; emphasis on economic dynamics.

62. Contemporary Urban Issues (3) spring
Review of the literature on urban issues: poverty, law enforcement, race relations, planning and fiscal responsibility; emphasis on New York City.

125. American Ethnic Groups (3) fall, 1984
Immigration to the United States; persistence of cultural differences over generations; patterns of conflict and accommodation; assimilation; ethnic politics; emphasis on white Euro-American nationality groups; with some

attention to Afro-, Hispano-, Asian- and native Americans. Amidon

300. Apprentice Teaching (3)
Opportunity for selected seniors to assist in all aspects of instruction, usually in US 62, under close supervision. Prerequisite: consent of the program director.

321. White Protestant Americans (3) fall, 1983
Cultural and religious origins of the historically dominant ethnic group in the United States; rise and decline of a national Anglo-Protestant urban elite; persistence of regional and nonelite subcultures; "Wasp" sterotypes and anti-Protestant themes in American culture. Amidon

324. The Irish in American Society (3) spring, 1985
Cultural, economic and political experience of a major white ethnic group in the United States; Irish Catholics vs. Scotch-Irish Protestants; immigrant poverty; priests and prelates, ward healers and big-city bosses; Irish themes in American literature, humor and media culture; Irish radicalism: Amidon

326. The American Italian Community (3) spring, 1984
European background of Italian emigration; patterns of first-generation experience in the United States; distinctive values, folkways and institutions; the "Mafia"; political behavior; upward mobility and assimilation; achievements of outstanding individuals; interaction with general American culture. Amidon

328. The American Jewish Community (3) spring, 1985
Historical and sociological perspectives on the experience of an important minority in the United States; communal institutions and social patterns; orientation toward achievement and secular success; Jewish influences in American culture; anti-Semitism, acceptance, and survival as a distinct subculture. Amidon

363. Philadelphia: Development of a Metropolis (3) fall
Philadelphia as an early experiment in the deliberate creation of a new community; the rise of the port; industrialization and immigration; creation of a hinterland and competition with rival centers; upper-class family continuity; religious life and institutions; political history.

365. Lehigh Valley: Development of a Regional Center (3) summer
Analysis of the growth and character of regional centers ("provincial towns") in general; geography of the Lehigh Valley; development of the economic, cultural and political characteristics of this area; public policy in such areas as economic development, physical planning, social welfare and human relations. Primarily for summer session, but may occasionally replace US 363 in the fall.

371, 372. Special Topics (3-6)
A seminar on a topic of special interest in urban studies. Prerequisite: consent of the program director.

For Graduate Students

An urban studies option is offered under the master of public administration(M.P.A.)degree, which is administered by the department of government.

Geographical Distribution

All figures are for fall, undergraduates only.

	1981	1982
Alaska	1	1
Arizona	1	1
Arkansas	2	2
California	19	17
Colorado	8	6
Connecticut	260	268
Delaware	42	40
District of Columbia	9	5
Florida	30	30
Georgia	5	12
Illinois	18	13
Indiana	4	3
Iowa	1	1
Kansas	2	1
Kentucky	2	3
Louisiana	3	4
Maine	5	6
Maryland	124	133
Massachusetts	94	110
Michigan	8	5
Minnesota	5	3
Mississippi	1	
Missouri	6	7
Nebraska	4	1
Nevada		1
New Hampshire	8	12
New Jersey	1269	1305
New Mexico	2	
New York	645	645
North Carolina	6	6
Ohio	41	37
Oklahoma	1	1
Oregon	1	1
Pennsylvania	1779	1680
Rhode Island	4	5
South Carolina	2	3
Tennessee	2	2
Texas	9	7
Vermont	4	4
Virginia	24	25
Washington	2	1
West Virginia	3	3
Wisconsin	6	4
Wyoming	1	
total	4463	4414

Belgium	4	3
Bermuda		2
Bolivia		1
Brazil	1	2
British West Indies	2	1
Canada	2	3
Colombia		2
Costa Rica	1	2
Cyprus	1	4
Ecuador	1	
El Salvador	1	
France	1	1
Gambia		1
Germany	2	4
Greece		4
Guatemala	2	2
Hong Kong	1	2
India		1
Indonesia	1	1
Iran		1
Italy		1
Japan		2
Korea		5
Kuwait	1	2
Macao		1
Malta	1	
Morocco	1	
Netherlands	1	1
Nigeria		1
Pakistan	2	2
Peru	2	2
Philippines	1	1
Puerto Rico	7	8
Saudi Arabia	2	3
Singapore		1
Spain	1	1
Switzerland	3	2
Thailand	3	3
Trinidad		2
Turkey	3	
United Kingdom	4	6
Uruguay		1
Venezuela	5	4
Virgin Islands	1	1
total	58	87
final total	4521	4501

VI

An Overview From Past to Present

Lehigh University is an independent, nondenominational, coeducational university.

Founded in 1865 as a predominantly technical four-year school, the university now has approximately 4,400 undergraduates within its three major units—the College of Arts and Science, the College of Business and Economics, and the College of Engineering and Physical Sciences—and approximately 1,800 students enrolled in graduate programs offered through the Graduate School in these colleges and in the School of Education. There are undergraduates from 44 states and 28 foreign nations, although the majority of students are from the Middle Atlantic region.

The university is situated on the north slope of South Mountain overlooking Bethlehem, Pennsylvania. The South Mountain campus encompasses approximately two-hundred acres. An athletic complex comprising approximately 600 acres in Saucon Valley is located two miles from the main campus on the other side of South Mountain.

While the upper portion of the main campus remains in woodland, the area where many classrooms are located includes a long-established area that still bears testament to its former status as an arboretum. An abundance of trees and plants provide a pleasant environment. In the spring, the magnolias planted by the university's sixth president, Henry S. Drinker, blossom. He was an engineer, a lawyer, and a leading naturalist. Some of the trees predate the founding of the university. Others, such as the delicate, blue-flowering Chinese tree of heaven, were planted in this century. There are catulpas, cypresses, white birches, and massive English beeches. Of special interest is the Hutchinson collection of English boxwoods that graces the Alumni Memorial Building promenade.

Sayre Park, the wooded refuge that rises to the top of the mountain, is the setting for many living groups. The residences are reached via winding private roads. The Sayre Park area is considered to be one of the most beautiful collegiate residential areas in existence, with a variety of contemporary and traditional student dwellings located in a kind of neighborhood of the young nestled into the mountainous, wooded site.

All residential units on the campus afford students who live in them a panoramic view of the Lehigh Valley. It can be said at Lehigh that, like the show tune, "on a clear day you can see forever." The foothills of the Poconos are visible to students across the expanse of valley, with an especially good view afforded from The Lookout, an overlook situated some 630 feet above the valley below.

Because of the unique setting, some interesting architectural treatments are possible. Several dwellings are entered from upper levels, even from the third floor.

A substantial portion of the upper level of the campus is maintained as a nature preserve, where students find quietude for studying outdoors when the weather is warm. The preserve includes flora indigenous to the area and wild animals in their natural habitat, including deer, squirrels, chipmunks, raccoons, and a variety of birds that would please any ornithologist. Students of geology literally have field days on the campus.

Besides its Bethlehem campus, the university also operates The Wetlands Institute, located on a thirty-four-acre site adjoining a coastal salt marsh near Stone Harbor, N.J. The institute has laboratories and dormitory space for students. It is concerned with the preservation and improvement of the coastal environment. Many undergraduates study at the institute.

The board of trustees and university officers have established and enforce policies designed to preserve the natural beauty of the campus. It is their contention that the environment in which the young adult university student pursues knowledge can make the total educational experience more meaningful, and that the ideal environment is separate and unique from the distractions of the non-academic community.

There are approximately 370 members of the faculty, teaching a total of more than 2,000 course titles. Not all of these courses are offered every semester. Among faculty members who are tenured and to whom the university has a permanent commitment, some 95 percent hold the doctorate degree (Ph.D. or Sc.D.).

The ratio of students to faculty at Lehigh is 12 to 1, whereas the national average is approximately sixteen students per faculty member.

In total, there are more than 1,100 employees of the university, making it the second or third largest employer in the community.

History and Purpose

The principal author of the brief history of Lehigh University that follows, Dr. W. Ross Yates, holds the bachelor of arts and master of arts degrees from the University of Oregon, in his native state. He received the doctor of philosophy degree from Yale University and studied in France on a Fulbright Scholarship. He joined the Lehigh staff in 1955 and served as dean of the College of Arts and Science from 1963 to 1972. Today he is professor of government.

Dr. Yates has written a history of the Lehigh Valley and served as general editor of two volumes concerning the history of Bethlehem.

When the sound of the last cannon of the Civil War died away, statesmen, educators, and industrial pioneers marshalled the victorious forces of the North and turned their attention to education. They wanted to increase the number of trained scientists, engineers, and other skilled people so they could transform the vast natural resources of the country into a strong and independent national economy.

Asa Packer was one of the industrial pioneers. He built the Lehigh Valley Railroad and controlled a coal-mining empire in the mountains of eastern Pennsylvania. He knew, as did many others, that a strong national economy depended on more than technical skills. It needed above all people broadly educated in the liberal arts and sciences—people who could combine practical skills with informed judgments and strong moral self-discipline. He kept this in mind when founding and endowing Lehigh University.

The bishop's account. The site that Packer chose for his university was a railroad junction across the Lehigh River from Bethlehem, a community founded in 1741 by Moravian missionaries. William Bacon Stevens, Episcopal bishop of the Diocese of Pennsylvania and the first president of the university's board of trustees, in 1869 described the origin of the university as follows:

"In the fall of 1864 an interview was requested of me by the Hon, Asa Packer, of Mauch Chunk (now Jim Thorpe), Pa. He came to my house in Philadelphia, and said that he had long contemplated doing something for the benefit of his State, and especially of the Lehigh Valley. From that valley he said he had derived much of the wealth which GOD had given to him, and to the best interests of that valley he wished to devote a portion of it in the founding of some educational institution, for the intellectual and moral improvement of the young men of that region.

"After conversing with him a little while, and drawing out his large and liberal views, I asked him how much money he purposed to set aside for this institution, when he quietly answered that he deigned to give $500,000. At the time of this interview no one in this country, it is believed, had offered in a single sum such an endowment for a literary institution. It was the noblest offering which an American had ever laid on the altar of learning, and more than equaled many royal donations which have carried down the names of kings as patrons of European universities.

"Filled with profound emotions at the mention of such a gift for such an object, I asked the noble donor what specific plans he had dreamed in his own mind in reference to it. His reply was, 'I am not much acquainted with these matters, but you are, and I want you if you will to devise a plan which I can put into effective operation.' I told him that I would make the attempt. I did so. I drew up the outline sketch of such an institution as I thought would give the largest results for the means used, and submitted it in a few weeks to his inspection.

"He examined it with the practical judgment and business habits with which he deals with all great questions, and adopted the scheme as the basis of his future university.

"The first meeting of the Board of Trustees, selected by Judge Packer, met at the 'Sun Hotel,' in Bethlehem, July 27th, 1865, and began to organize the work before them."

The early years. The trustees followed several principles in setting up the university. One was that of combining scientific and classical education. They considered both to be practical. The principle carried forward an ideal of the great 17th-Century Moravian educator, John Amos Comenius. A motto taken from the works of Francis Bacon was used to summarize this principle, namely, *Homo minister et interpres nature*— man, the servant and interpreter of nature, to use a free translation. Today, that motto lives on at Lehigh, being an element in the university seal.

The trustees chose as first president a man whose education and habits expressed this principle, Henry Coppee. They established five schools, including a school of general literature in addition to four scientific schools of, respectively, civil engineering, mechanical engineering, mining and metallurgy, and analytical chemistry.

Another principle upon which the trustees insisted was that of keeping the size of the student body proportionate to the abilities of the faculty to teach them well. The university would admit only as many freshmen each year as it could be assured of providing with the highest quality of education. In the 19th Century the total enrollment never exceeded several hundred students; the size has increased significantly in recent decades, along with the number of faculty members.

The trustees also insisted that Lehigh was to be nondenominational and would have an admission policy based on merit. Competitive examinations were held for applicants for admission. From 1871 to 1891 no tuition was charged, but the national financial crisis at the turn of the century decimated the value of the Lehigh Valley Railroad stock that Packer had given to Lehigh, which was the principal source of income.

At first the student body was entirely male. The contemporary ideological climate would permit nothing else. But around 1916, several decades after the establishment of graduate studies, women were admitted to graduate programs. In 1971, the university opened its undergraduate program to them as well. Today men and women applicants are considered on an equal basis.

Flannel shirts. From the first, the students were serious-minded. In 1924, Catherine Drinker Bowen, daughter of president Henry Sturgis Drinker and later a famous biographer, published a brief *History of Lehigh University,* in which she commented:

"Ask any college professor which brand of boy he would prefer to teach, the cigarette brand or the flannel shirt variety. Right here we offer ten to one the flannel shirts...Lehigh still holds to the emblem of the flannel shirt—long may it wave! Engineers come to college to work. A writer in the *Syracuse Post* in 1895 spoke truthfully when he said, 'From the first, Lehigh's characteristic has been her earnestness. It is the boast of her graduates, the inspiration of her students. Men go there to learn to take a useful part in the economy of life'."

The university community was constantly infused with new faculty and students determined to renew and rework the original principles in the light of changing times. The students' ambition and zeal bore fruit; as alumni they carried the university's educational goals into

the work of nation-building. And, having received, they gave to perpetuate Lehigh's work of service.

Today, Lehigh University still adheres to Asa Packer's goal of a liberal and scientific education for practical service. Faculty and students work to maintain quality. Generous support from individuals, foundations, and government help Lehigh to retain high quality of education and faculty while keeping tuition as low as possible. (Tuition covers approximately sixty percent of the cost of a Lehigh education.)

Presidents of the University

Many individuals—alumni, faculty, students, and friends—have made significant contributions to Lehigh University during the hundred-plus years since its founding. Few, however, have been so visible in their contributions as Lehigh's presidents. Each of the ten earlier presidents brought different talents and experiences to the office.

In 1983, the university began a new era under its eleventh president, Dr. Peter Likins, whose inauguration in April would bring to the campus people of note from academia, business, and government. A mini-biography of Dr. Likins appears below.

The Lehigh presidents are described in the following paragraphs.

Henry Coppee (1821-1895). Coppee served as a railroad engineer in Georgia, a captain in the Army during the Mexican War, and taught at West Point and at the University of Pennsylvania before becoming first president 1866. Coppee wrote extensively in a number of fields, including military science and English literature.

During his tenure as president, which lasted until 1875, much building was done on the new university campus. A Moravian church on Packer Avenue was remodeled into Christmas Hall; a house for the president was erected on campus; Sayre Observatory (now the Sayre Building) and Saucon Hall were completed; and Packer Hall (since 1958 called the University Center) was erected.

During Coppee's tenure, the divisions of the university included civil engineering, mechanical engineering, mining and metallurgy, analytical chemistry, and a school of general literature. Coppee himself lectured in history, logic, rhetoric, political economy, and Shakespeare.

John McDowell Leavitt (1824-1909). Leavitt was an Episcopal clergyman who graduated from Jefferson College and taught at Kenyon College and at Ohio University. During his incumbency, the university was divided into two schools, General Literature and Technology. As of 1876, a student could receive two engineering degrees by taking a longer course, and beginning in 1877 the master of arts, doctor of philosophy, and doctor of science degrees were established.

During the Leavitt administration, Linderman Library rotunda was completed in 1877. Asa Packer died in May, 1879, and Founder's Day was held in his honor the following October.

Robert Alexander Lamberton (1824-1893). Lamberton became president in 1880. A graduate of Dickinson College, Lamberton practiced law in Harrisburg and was a university trustee when asked to become president. During his administration, the first master of arts degree was conferred, and students and the community witnessed the first Mustard and Cheese dramatic presentation.

Building for the growing university continued. A gymnasium (now Coppee Hall) was erected, and Chandler Chemistry Laboratory was built. Packer Memorial Church was completed in 1887. In addition to building a physical plant, Lehigh was also building its reputation for academic excellence; the mechanical engineering department was established in 1881 and the Lehigh chapter of Phi Beta Kappa was founded in 1887. Lehigh beat Lafayette in football for the first time in 1887.

Thomas Messinger Drown (1842-1904). Drown studied medicine at the University of Pennsylvania and went abroad to study chemistry. Thereafter he was professor of chemistry at Lafayette College for eight years. In 1895 he assumed the presidency of Lehigh and was greatly interested in furthering the university's development as a technical school. His first years were difficult ones; he was forced to face the possibility that Lehigh would have to close because the Panic of 1893 had ruined the university's stock holdings in the Lehigh Valley Railroad.

Nevertheless, Lehigh managed to grow in enrollment, academics, and in physical plant. The physics laboratory burned and was rebuilt. Williams Hall was completed. The curriculum leading to a degree in arts and engineering was established, as was the department of zoology and biology. New curricula were adopted in metallurgical engineering, geology, and physics.

Drown died in office in 1904. Professor William H. Chandler became acting president.

Henry Sturgis Drinker (1850-1937). Drinker, an 1871 Lehigh graduate, who served as president from 1905 to 1920, was the only university alumnus ever to hold that position. His appointment was symptomatic of the increasing alumni interest in university affairs. In 1907, the alumni endowment fund began, the *Lehigh Alumni Bulletin* was first published in 1913, and the Alumni Association was incorporated in 1917.

Drinker was tapped for the presidency. Besides being a lawyer, he was also a mechanical engineer and had been largely instrumental in solving the problems of constructing the Musconetcong Tunnel, a two-mile-long engineering feat that made possible a railroad line between Easton, Pa., and New York. He started a tradition of businesslike management of university affairs.

During Drinker's fifteen years as president, Lehigh's endowment increased from $1.1 million to $3.1 million. More buildings were completed: the original section of Fritz Engineering Laboratory, Drown Hall, Coxe Mining Laboratory, Taylor House, Taylor Gymnasium and Field House, and Taylor Stadium. The college commons, Lamberton Hall, was completed. Dr. Drinker's interest in horticulture led to the planting of many rare and interesting trees and plants. Included among the plantings are flowering specimens from the Orient. Interest in these plants may have been related to the fact that Drinker was born in Hong Kong of American missionary parents.

A teacher's course and business administration course were begun in 1909 and in 1918 the university was divided into three colleges, liberal arts, business administration, and engineering—the roots of the three colleges of today. Evening classes commenced in 1920 and Army ROTC was established in 1919.

Dr. Drinker's daughter, Catherine Drinker Bowen, went on to become a writer of note. Her experiences as the daughter of a Lehigh president and occupant of the President's House are recorded in *Family Portrait* (Atlantic Little-Brown).

Drinker resigned in 1920 and Natt M. Emery, vice president, served as chief executive officer until 1922.

Charles Russ Richards (1871-1941). Dr. Richards took office in 1922. During the thirteen years of his presidency, the first graduate degrees were awarded to women. Lehigh faced a shortage of students from 1929 to 1936 as a result of the Depression, but the newly established office of admission, as well as university scholarships, fellowships, and deferred tuition payments helped to ease the shortage.

Changing concepts of education were evident in several newly organized academic offerings: philosophy, music, psychology, journalism, history, and fine arts. The majors system was instituted and senior comprehensive

examinations were begun by the Arts College. The placement bureau, a public relations office, and a student health service were started. The division of intercollegiate athletics and physical education was officially recognized.

The Alumni Memorial Building—completed in 1925 as a memorial to the Lehigh alumni who served in World War I—and Packard Laboratory were completed in 1925, as well as a major addition to Linderman Library.

Clement C. Williams (1882-1947). Dr. Williams, a civil engineer by profession, became president in 1935. Not only did the university celebrate its 75th birthday in 1941, but Williams' presidency saw an era of unprecedented alumni support. Undergraduate enrollment rose to an all-time high, passing 2,000 in 1938. Richards and Drinker residential houses, and the Ullmann section adjoining the Chandler Chemistry Laboratory, were built. Grace Hall, the first arena-type facility of any size on campus, was completed in 1940. The building was the gift of Eugene G. Grace, 1899, president of the board of trustees.

A graduate school implemented the programs in the three colleges and the first Ph.D. since 1896 was granted. Williams retired in 1944, and the university was without a president for approximately two years.

Martin D. Whitaker (1902-1960). Dr. Whitaker, who had been director of the Atomic Energy Commission Laboratory at Oak Ridge, Tennessee, and had worked in developing the atomic bomb, faced the responsibility of helping the university community readjust to peacetime conditions after World War II.

During his fourteen years as president, Lehigh's assets nearly tripled to $45 million; the endowment more than doubled to $18 million. Many buildings were renovated, and the Dravo House and McClintic-Marshall House residence halls were built. The faculty increased in number by 75 percent and the first endowed distinguished professorships were established.

The most remarkable project associated with the Whitaker years was the Centennial development program, begun in 1959. It raised more than $22 million for faculty salaries and construction that later included the Whitaker Laboratory for Metallurgical and Chemical Engineering.

An extensive renovation and enlargement project was undertaken in Packer Hall in 1957, and, upon completion in 1958, the building was renamed the University Center.

Academically, the Whitaker years included the inception of an adult education program. Twenty departments offered the master's degree and twelve the doctor of philosophy.

Dr. Whitaker died in office.

Harvey A. Neville (born 1898). Dr. Neville, who lives in Bethlehem, took office in 1961. He was the only faculty member ever elected president. His association with the university began in 1927 as an assistant professor of chemistry. During his three-year term as president, the first phase of the Saucon Valley athletic complex was completed, and Sayre Field was opened atop South Mountain. The Center for Information and Computing Science was established.

Deming Lewis (born 1915). Willard Deming Lewis became president in 1964 after a distinguished career as a space engineer and research administrator.

Lewis comes from a remarkable family that traces its American roots to William Lewis, an Englishman who settled in the Massachusetts Bay Colony in 1640. Deming's great-grandfather and grandfather were presidents of the Lewis Manufacturing Co., a textile firm in Walpole, Mass. Willard Lewis, Deming's father, moved to Augusta, Ga., and eventually become owner of Riverside Mills there.

Deming was admitted to Harvard at age fifteen, but his mother thought him too young to attend. So he waited and entered Harvard at age sixteen, eventually receiving three degrees there, as well as two degrees from England's Oxford University, where he was a Rhodes Scholar in advanced mathematics. At Harvard, Lewis worked with Ted Hunt, the father of high fidelity, writing the equations describing a stylus sliding through a warped groove.

In 1941, Lewis joined Bell Telephone Laboratories, and in 1962 he was one of four Bell System executives who initiated Bellcomm, Inc., in Washington, D.C. Bellcomm engineered systems for the Apollo project that placed the first man on the moon.

Dr. Lewis holds thirty-three-U.S. patents on such devices as microwave antennas and filter and digital error detection systems. Now a resident of Bethlehem, he is a director of Bethlehem Steel Corporation, Pennsylvania Power and Light Co., Fairchild Industries, Inc., Fischer & Porter Co., and Zenith Radio Corp.

During the Lewis administration, the university's visiting committees—consisting of outside experts—were established in 1964. New programs included majors in natural science, biology, social relations, geological sciences, environmental science and resource management, and religion studies. Minors for engineering students in such fields as business, history, and social sciences were begun. Interdisciplinary majors such as computer engineering, computing and information science, applied mathematics, management science, American studies, and many others were instituted.

Six research centers and seven institutes were established. The most recent additions, in 1980, were the Biotechnology Research Center and the Institute for Research and Development in Education. The graduate-level School of Education was reorganized into three departments. In 1980, it added the specialist in education graduate degree, and in 1981, the specialist in educational technology.

Gifts to the university were unprecedented. The first phase of the New Century Fund capital campaign yielded $1.1 million more than its goal of $30 million; the second phase, now in progress, will easily surpass its goal of $41.5 million. Nearly $90 million was contributed while Lewis was president.

The university grew dramatically in physical facilities, with construction totaling more than $30 million. The buildings include Maginnes Hall; Whitaker Laboratory; Mart Science and Engineering Library; the Central Heating and Refrigeration Building; Sinclair Laboratory; the Seeley G. Mudd Building; Rathbone Hall dining room; thirteen fraternity houses; the Centennial I and Centennial II residential complexes; the Trembley Park student apartment complex; the Saucon Married and Graduate Students complex, completion of the acquisition of the Saucon Valley athletic lands and the construction there of the Varsity House; the squash courts, the $1.86 million Philip Rauch field House, and the $3.7 million Stabler Athletic and Convocation Center; establishment of the off-campus student residential cluster; and the completion in 1979 of Brodhead House, a six-story residence hall for undergraduates. In addition, the $1.25 million restoration of Packer Memorial Church was undertaken, as well as a million-dollar renovation of Packard Laboratory. Plans are near completion for a $10 million, high-technology building to serve the library system.

In 1971, women were admitted as undergraduates for the first time, eventually increasing the size of the student body by approximately nine-hundred. Reginald Jennings, a young Lehigh graduate, served as the first black member of the board of trustees. In 1978 Mrs. Henry A. Kissinger, herself the daughter of a Lehigh trustee, became the first woman member of the board, a post she continues to hold.

Increase in interest in Lehigh among prospective students has been dramatic. There were 2,837 applicants for 818 freshman seats in 1964, the year Dr. Lewis took office. In 1982, 6,800 applied for the 1,050 seats.

Shortly before Dr. Lewis achieved emeritus status, the

university achieved national recognition with its high-technology undergraduate program in Computer-Aided Design/Computer-Aided Manufacturing, supported by several million dollars in contributions from industry.

Dr. Peter Likins. After a carefully organized and intensive search for a successor to Deming Lewis, Dr. Peter Likins was chosen to assume the presidency on July 1, 1982. His inauguration, scheduled for April 16, 1983, would follow a week-long series of special colloquia, meetings, and social activities in observance of the occasion.

Likins came to Lehigh as eleventh president from Columbia University, where he was provost in charge of engineering and applied science programs as well as the graduate schools there. At this writing, it is too early to foretell just what directions the university might take under Dr. Likins' guidance, but there will certainly be continued strengthening of academic and research programs. A native of California, Dr. Likins is relaxed and informal in his interpersonal dealings and has regular personal contact with undergraduates. A former collegiate wrestler of some note (in 1982 he was named to the National Wrestling Hall of Fame), he and members of his family are regular attendees at Lehigh home wrestling meets—and they are vociferous fans.

Dr. Likins is considered to be a public speaker of accomplishment. His years spent in teaching are evident when he speaks; what he has to say is organized into blocks of information, one block building on the others in a logical way. He customarily writes his own presentations.

Shortly after his arrival, Dr. Likins was substantially involved in the university's effort to be designated as the home base of one of several consortiums being established in Pennsylvania to facilitate development of high-technology industry. The concept, known as the Ben Franklin Partnership program, holds the potential for a more focused alliance between academia and the industrial world that also could prove beneficial to the economy of the region.

Dr. Likins is a distinguished academic administrator, a seasoned educator in engineering, an expert in spacecraft dynamics and control, an author of textbooks in engineering mechanics, a researcher who has written for more than fifty publications, and a consultant to governments and industry.

He earned the B.S. in civil engineering from Stanford University in 1957, the master of science in civil engineering from Massachusetts Institute of Technology the following year, and the Ph.D. in engineering mechanics from Stanford in 1965. He joined Columbia as dean of the School of Engineering and Applied Science in 1976 and was named provost in 1980. Earlier, he was a development engineer at the Jet Propulsion Laboratory of the California Institute of Technology, and subsequently served as associate dean of engineering at the University of California at Los Angeles.

Dr. Likins and his wife, Patricia, have six children, five of whom reside in the President's House.

University Buildings

During the past fifteen years, the university has constructed approximately thirty academic, residential and research buildings with an aggregate value of more than $45 million.

Most recent of the structures are the Seeley G. Mudd Building and Neville Hall in the chemistry complex (1975), the Philip Rauch Field House (1975), the Sherman Fairchild Laboratory for Solid-State Studies (1976), the Stabler Athletic and Convocation Center (1979), and the Brodhead House high-rise residential facility (1979).

In all, there are approximately 100 academic, residential, and research buildings available for use by the university community.

Campus Landmarks

Alumni Memorial Building (1925). This Gothic edifice, housing university administrative offices and those of the Lehigh University Alumni Association, Inc., represents a memorial to the 1,921 alumni who served in World War I and the 46 who died. The building was designed by Visscher and Burley, a partnership of two alumni, Theodore G. Visscher, 1899, and James Lindsey Burley, 1894.

Linderman Library (1877). The rotunda was built by university founder Asa Packer as a memorial to his daughter, Lucy Packer Linderman. The rotunda is almost entirely surrounded by a Gothic facade constructed in 1929. The 1929 additions were designed by Visscher and Burley. The building houses 490,000 volumes and the rare book collection. Renovation of the reading room was completed in 1982.

Packer Memorial Church (1887). The church was the gift of Mary Packer Cummings in memory of her father, founder Asa Packer. It was dedicated on Founder's Day, October 13, 1887. Restoration of the structure has been partially completed; the total project will cost some $1.25 million with completion expected before the end of this decade. The building was designed by the architect Addison Hutton; the stained-glass window over the main door is atributed to Louis Comfort Tiffany.

President's House (1868). This 21-room residence is the home of university presidents. Visiting dignitaries are entertained there. In 1982, Dr. and Mrs. Peter Likins moved into the dwelling.

University Center (1868), originally known as **Packer Hall.** When construction began in 1865, a railroad was built to transport stone to the site. The building was extensively renovated and enlarged in 1958.

Academic and Research Facilities

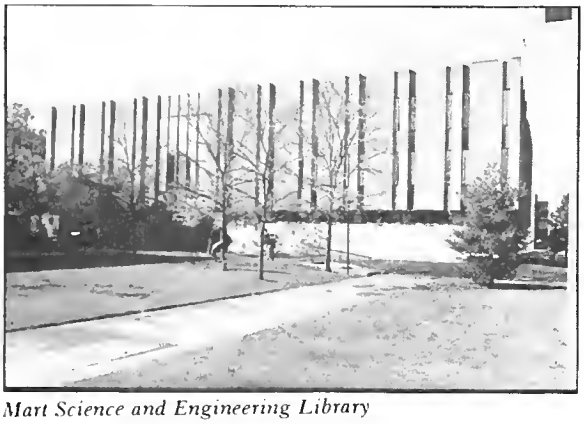
Chandler-Ullmann Hall (1883, 1938, respectively). These adjoining buildings formerly were individually identified as the William H. Chandler Chemistry Building and the Harry M. Ullmann Chemistry Laboratory. Chandler served as acting university president from November, 1904, to June, 1905, and taught chemistry from 1871 to 1906. Ullmann served as chairman of the chemistry department. The combined name was adopted in 1975. The department of art and architecture, urban studies, and psychology, the Marine Geotechnical Laboratory, the office of Lehigh University Art Galleries and the division of speech and theater are located in Chandler-Ullmann.

Christmas-Saucon Hall (1865 and 1872, respectively). Christmas Hall is the university's oldest building. When Asa Packer acquired the South Mountain site for the university in 1865, a Moravian church was being constructed. The newly formed university took over the building and completed it for use in recitations and as a dormitory and chapel. The name Christmas Hall was chosen in keeping with Moravian religious tradition. In 1872, Saucon Hall was constructed a short distance to the east of Christmas Hall. The buildings were connected with the construction of a "hyphen" in 1926. The building houses the department of mathematics and the office of career planning and placement services.

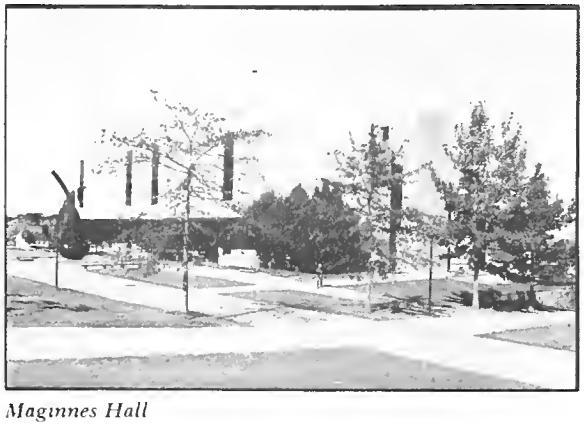
Coppee Hall (1883). The building originally housed classrooms and a gymnasium. It is named in honor of Henry Coppee, Lehigh's first president. Today the building houses the department of modern foreign languages and literature, and The Learning Center.

Alumni Memorial Building

Linderman Library



Mart Science and Engineering Library



Maginnes Hall

Coxe Laboratory (1910). Originally a mining laboratory, the structure honors the memory of Eckley B. Coxe, a pioneer mining engineer and a trustee of the university. The building now houses the Materials Research Center. A plaque in the building says that Coxe was "genuine and simple-hearted" and "sympathized with young men to whom his life was an example."

Drown Hall (1908). Erected by friends and alumni, the building honors the memory of Thomas M. Drown, president from 1895 to 1904, and is headquarters for the College of Business and Economics.

Fritz Engineering Laboratory (1909, 1955). The laboratory honors the memory of John Fritz, father of the steel industry in the United States and a member of the university's original board of trustees. Fritz provided funds for the original section; a seven-story addition accommodates the university's testing machine, which is capable of applying a five-million-pound load to tension or compression members up to forty feet in length. The hydraulic testing machine is the second-largest such facility in the world. The laboratory is used primarily by the department of civil engineering.

Johnson Hall (1955). The building houses the university health service, the counseling service, the Fraternity Management Association, the offices of the vice president for student affairs, some offices of business college faculty, the chaplain's office and the motor vehicle office. Earle F. "Coxey" Johnson, '07, a director of General Motors and university trustee, made a major anonymous contribution toward the structure. In 1976 the university obtained permission from Mr. Johnson's family to name the building in his memory.

Lamberton Hall (1907). The structure originally served as the university commons and dining room until the renovation of the University Center. The building honors the memory of Robert A. Lamberton, third president of the university. Today the building houses the music department.

Maginnes Hall (1970). The contemporary multilevel structure is headquarters for the College of Arts and Science and also houses the departments of English, history, government, international relations, classics, and religion studies. The university bookstore is located on the ground floor. The building is named for Albert B. Maginnes, '21, a lawyer and trustee of the university from 1954 to 1966. Mr. Maginnes was the father of Nancy Kissinger, wife of the former U.S. secretary of state. She was named to the board of trustees in 1978.

Mart Science and Engineering Library (1968). This contemporary structure honors the memory of Leon T. Mart, '13, and his son, Thomas, '51. It houses more than 130,000 volumes in the fields of engineering, mathematics, and natural and physical sciences. A $10 million addition will be constructed beginning in 1983.

Seeley G. Mudd Building (1975). This seven-story tower houses the chemistry department. It is part of the $7 million chemistry complex, which also includes an adjoining structure, Neville Hall, housing three classroom-auditoriums. The late Dr. Mudd was a California medical doctor. The Seeley G. Mudd Foundation, of Los Angeles, made a major gift toward the building. The building was designed by Walker Cain Associates, successor firm to McKim, Mead & White.

Newman Association Center. This Victorian structure, until the mid-1970s occupied by elderly sisters who had refused to sell the property to the university, was acquired by the Newman Association and now serves as a center for Roman Catholic students and as a residence for its director.

Packard Laboratory (1929). The structure was the gift of James Ward Packard, Class of 1884, the electrical pioneer and inventor of the Packard automobile who

served as a university trustee in 1927 and 1928. The first Packard automobile (1898) is displayed in the lobby. The building is the headquarters for the College of Engineering and Physical Sciences and also houses classrooms and laboratories for the departments of electrical and computer engineering, industrial engineering, and mechanical engineering and mechanics. Packard Laboratory Auditorium accommodates large classes. This building has been extensively renovated over a recent period of time.

Philosophy Building. This small structure near Packer Memorial Church served for many years as the chaplain's residence. Today it is the home of the philosophy department. The building was constructed in the 19th Century.

Physics Building (1892). This massive, five-story stone structure (240 feet long) contains laboratories and teaching facilities for undergraduates and graduate students in physics.

Price Hall. This structure formerly was a brewery named Die Alte Brauerei. In 1912 it was remodeled to serve as a dormitory, and it was named in honor of Henry Reese Price, president of the university board of trustees from 1912 to 1924. Today it serves as home of the social relations department.

Rathbone Hall (1971). This student dining facility, with its window walls affording a panoramic view of the Lehigh Valley, bears the name of its donor, Monroe Jackson Rathbone, '21, president of the university board of trustees from 1957 to 1973. Mr. Rathbone was chairman of the board, Standard Oil Co. (New Jersey), now known as Exxon Corp., and was a major innovator in the oil industry. He died in 1976. The lower level of Rathbone Hall houses the residence operations office.

Sherman Fairchild Laboratory for Solid-State Studies (1976). This $1.9 million research facility provides offices, laboratories and equipment for solid-state studies. It was the gift of the Sherman Fairchild Foundation, of Greenwich, Conn. The late Mr. Fairchild was an iconoclastic inventor who made contributions in a variety of fields. He was the son of the founder of IBM.

Sinclair Laboratory (1970). This contemporary-styled research facility houses the Center for Surface and Coatings Research and the National Printing Ink Research Institute. It is named in honor of Francis MacDonald Sinclair, a New York City ink manufacturer, and was the gift of his widow, Jennie H. Sinclair.

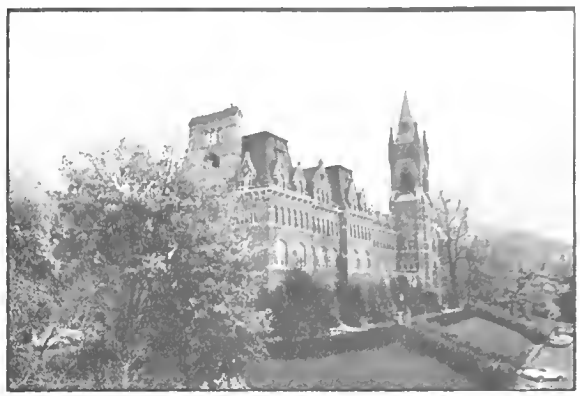
Whitaker Laboratory (1965). This five-story structure with an adjoining two-level classroom-auditorium section honors the memory of Martin D. Whitaker, university president from 1946 to 1960. The buildings serve the department of metallurgy and materials engineering, and the department of chemical engineering. There are laboratories for high-pressure research and reaction kinetics, nuclear studies, analog computation, process control, high-temperature thermodynamics and kinetics, and fine structures and metallography.

Williams Hall (1903). This brick structure was the gift of the late Edward H. Williams, Jr., Class of 1875. Dr. Williams was a professor of mining and geology at Lehigh for twenty-one years. The building contains classrooms and laboratories for the departments of biology and of geological sciences. It also houses the Center for Marine and Environmental Studies. A greenhouse used by students of botany adjoins the building. The building was extensively renovated and a fourth story added in 1956 following a fire.

Athletic and Convocational Facilities

Grace Hall (1940). The building is named for its donor, the late Eugene G. Grace, Class of 1899, who was chairman of Bethlehem Steel Corp. and president of the

Packard Laboratory



University Center

Drinker House

Trembley Park

Sherman Fairchild Laboratory

university's board of trustees from 1924 to 1956. The building's lower level seats 3,200 and is used for intramural sports, basketball, and women's varsity volleyball as well as concerts and lectures. The upper level accommodates the military science and aerospace studies departments.

Philip Rauch Field House (1976). The field house is named for Philip Rauch, '33, its principal contributor. Mr. Rauch is chairman of the executive committee of Parker Hannifin Corp. The $1.86 million building has 62,000 square feet of uninterrupted floor space—the equivalent of two football fields—for a variety of athletic activities. It has a six-lane, one-eighth-mile flat track.

Saucon Valley athletic complex (1968). The complex for athletic activities, located approximately two miles to the south of the South Mountain campus, encompasses some 600 acres. Facilities include playing fields and a track and a cross-country course as well as tennis courts, squash courts, the Philip Rauch Field House, and the Stabler Athletic and Convocation Center. Use of the area began in the early 1960s. The university acquired the final pieces of the tract in 1970.

Sayre Field (1961). Located atop South Mountain, the field is used for softball and other sports. Its location affords a sweeping view of the eastern Lehigh Valley.

Squash Courts (1972). The building houses several courts.

Stabler Athletic and Convocation Center (1979). This $3.7 million arena provides seating for 6,000 persons for concerts, spectator sports and other events. University trustee Donald B. Stabler, '30, chairman of Stabler Companies, Inc., pledged $1.25 million toward the cost.

Taylor Gymnasium and Field House (1913 and 1904). This structure was the gift of Charles L. Taylor, Class of 1876, who was a friend and business associate of steel magnate Andrew Carnegie. There are two indoor swimming pools, five basketball courts, and two weight rooms.

Taylor Stadium (1916). The stadium seats 16,000 persons. It is located on the eastern end of the main campus, on the site of the athletic grounds that were opened in 1880. It is named for Charles L. Taylor, Class of 1876, a university trustee from 1882 to 1922.

Varsity House (1963). The building houses lockers and other facilities for varsity teams using the Saucon Valley athletic complex.

Wilbur Drama Workshop (1908). During most of its life, the building served as the university's power plant. Renovated during the 1970s for use by the division of speech and theater, it provides an open performing space, support areas, and a multi-purpose classroom/rehearsal space for the Theater at Lehigh dramatic series.

Power Facility

Central Heating and Refrigeration (1969). This building is unusual in that its apparatus is clearly visible to passerby on Packer Avenue through a glass front wall. The three boilers in the building can be fired by either oil or gas. Other equipment provides chilled water for air conditioning.

Residential Facilities

The university is primarily residential, with 95 percent of undergraduates living in facilities on the campus, including university-operated residence halls and independently managed fraternity and sorority houses, or on their own in the community.

Some 2,250 students live in on-campus residence halls, which are listed below, and in the Saucon Married and Graduate Students (SMAGS) apartments in Saucon Valley, and in the German House, Spanish House, Hillel House, and International House, situated in the Warren Square area. An additional 1,200 men live in thirty-one fraternity houses, while approximately 120 women reside in four sororities.

Residence Halls

Brodhead House (1979). This $2.1 million structure houses approximately two hundred students. It is the university's first high-rise residential facility. The six-story building includes student suites on the five upper floors, with a dining facility and lobby on the entrance level. The building adjoins the campus in South Side Bethlehem. It is named in memory of Albert Brodhead, a member of the Class of 1888 who died in 1933, leaving fifty-one Bethlehem properties to his alma mater.

Centennial I complex (1965)

Congdon House. Dr. Wray H. Congdon served as dean of students, dean of the Graduate School and special assistant to the president, retiring in 1961.

Emery House. It is named for Dr. Natt M. Emery, vice president and controller, who died in 1953.

Leavitt House. The Rev. Dr. John McD. Leavitt was the second president, serving from 1875 to 1879.

McConn House. C. Maxwell McConn was dean of the university from 1923 to 1938.

Smiley House. Dr. E. Kenneth Smiley served as vice president from 1945 to 1964.

Thornburg House. Named for Dr. Charles G. Thornburg, professor and head of the department of mathematics, 1895 to 1923. His grandson, Dick Thornburgh, who received a Lehigh honorary degree, is governor of Pennsylvania.

Centennial II complex (1965)

Beardslee House. Dr. Claude G. Beardslee was chaplain from 1931 to 1947. He was the father of Ruth Parr, Centennial School librarian, whose husband, Preston Parr, retired in 1982 as vice president and dean for student affairs.

Carothers House. Dr. Neil Carothers was dean of the College of Business and Economics from 1936 to 1949.

Palmer House. Dr. Philip M. Palmer was dean of the College of Arts and Science from 1936 to 1950.

Stevens House. The Rt. Rev. William Bacon Stevens, of Philadelphia, was Protestant Episcopal bishop of the Diocese of Pennsylvania and first president of the university's board of trustees. He was the principal architect of the university's original academic plan.

Stoughton House. Dr. Bradley Stoughton was dean of the Engineering college, 1936 to 1939.

Williams House. Dr. Clement G. Williams was president of the university from 1935 to 1944.

Other houses

Dravo House (1948). This stone edifice is the university's largest single residential facility. It honors two brothers, Ralph M. Dravo, Class of 1889, and Francis F. Dravo, Class of 1887, who founded the Dravo Corporation, a Pittsburgh-based international construction company with 13,000 employees in 1982. Both men served as university trustees. Both died in 1934. Funds they gave in endowment had a 1982 market value of $3 million.

Drinker House (1940). This stone building honors the memory of Henry S. Drinker, Class of 1871, university president from 1905 to 1920.

Hill House (1959). The building is the only non-fraternity residential unit in Sayre Park. The building was originally built as the home of Delta Tau Delta fraternity. The chapter was disbanded in 1981, but is expected to be reestablished in 1985.

McClintic-Marshall House (1957). This U-shaped stone structure was built in memory of Howard H. McClintic and Charles D. Marshall, both Class of 1888, who founded the McClintic-Marshall Construction Co. The firm was the world's largest independent steel fabricating firm before its acquisition by Bethlehem Steel Corp. in 1931. It built locks for the Panama Canal and the Golden Gate Bridge in San Francisco, structures which are depicted on murals in the lobby.

Taylor House (1907). The U-shaped bulding is one of the earliest concrete structures ever built. It was the gift of industrialist Andrew Carnegie in honor of his friend and associate, university trustee Charles L. Taylor, Class of 1876. The building will be closed during the 1983-84 academic year to allow for extensive renovations.

Trembley Park (1975). This contemporary, seven-building, $1.86 million undergraduate apartment complex is located west of the University Center. It is named for the late Francis J. Trembley, Lehigh professor and pioneer ecologist, who was responsible for identifying and preserving trees on the site of the complex.

Saucon Married and Graduate Students apartments

The five-building garden apartment complex on the periphery of the Saucon Valley athletic complex houses undergraduates and graduate students and three sororities. The buildings were completed in 1974 at a cost of $2 million. The buildings are named as follows:

Diamond. Dr. Herbert M. Diamond, professor emeritus of economics, retired in 1964.

Seeley G. Mudd Building

Gipson. Dr. Lawrence Henry Gipson, research professor emeritus of history, bequeathed his estate to the university to establish the Lawrence Henry Gipson Institute for Eighteenth-Century Studies. Dr. Gipson, who died in 1971, wrote a monumental fifteen-volume history. *The British Empire Before the American Revolution.* He won the Pulitzer Prize for volume 10, *The Triumphant Empire: Thunderclouds Gather in the West, 1763-1766.*

Hartman. The late Dr. James R. Hartman was chairman of mechanical engineering and mechanics.

More. Dr. Robert P. More, '10, dean of the College of Arts and Science, who also taught German for forty years, bequeathed to the university his $746,000 estate. He amassed a fortune after investing $3,000 in IBM stock. He died in 1970.

Severs. Dr. J. Burke Severs, of Bethlehem, is distinguished professor emeritus of English. The Chaucerian scholar retired in 1969.

Fraternities and Sororities

The university has a strong fraternity tradition, dating back to 1872 when Chi Phi was established. The most recently established fraternity was Alpha Epsilon Pi recognized in 1979, while the Delta Gamma sorority was established in 1982.

Twenty-six of the thirty-one Lehigh fraternities have houses located on campus, most in Sayre Park, while the other five have houses off campus. Contributions for construction and support of fraternity dwellings are made by chapter alumni. All are chapters of national fraternities.

An alphabetical listing follows. The date of the founding of the chapter is given in the first column. The second column lists the date the chapter occupied its present house; any additional date indicates the most recent addition or major renovation.

Alpha Chi Rho	1918	1968
Alpha Epsilon Pi	1979	1978
Alpha Sigma Phi	1929	1961
Alpha Tau Omega	1886	1966
Beta Theta Pi	1891	1968
Chi Phi	1872	1922, 1968
Chi Psi	1893	1916, 1955
Delta Chi	1952	1968
Delta Phi	1884	1963
Delta Sigma Phi	1931	1945
Delta Upsilon	1885	1968
Kappa Alpha	1894	1961
Kappa Sigma	1900	1973
Lambda Chi Alpha	1926	1973
Phi Delta Theta	1876	1919, 1963
Phi Gamma Delta	1886	1942, 1968
Phi Kappa Theta	1919	1966
Phi Sigma Kappa	1901	1957, 1970
Pi Kappa Alpha	1929	1903
Pi Lambda Phi	1915	1965
Psi Upsilon	1884	1909, 1966
Sigma Alpha Mu	1923	1966
Sigma Chi	1887	1953
Sigma Nu	1885	1970
Sigma Phi	1887	1950, 1961
Sigma Phi Epsilon	1907	1963
Tau Epsilon Phi	1963	1964
Theta Chi	1942	1964
Theta Delta Chi	1884	1937, 1967
Theta Xi	1904	1967
Zeta Psi	1973	1973

Not long after Lehigh admitted its first undergraduate women in 1971, the effort to establish sororities began. Three of the four sororities are housed in the Saucon Married and Graduate Students apartments complex. Alpha Phi was the first to colonize, in 1975, and it and two other sororities received recognition from the university in 1976. The others are Alpha Gamma Delta and Gamma Phi Beta. Delta Gamma was recognized in 1982 and occupies a residence in the community.

In Bethlehem, An Educational Tradition

Lehigh University shares in the historical heritage of Bethlehem, even though, having been founded in 1865, it is a relative newcomer. The fact that Lehigh was established in Bethlehem reflects the tradition of education established by its first settlers thirty years before the founding of the nation.

The first Moravians were among the many German religious sects that came to the New World, and especially to Pennsylvania, during the early 1700s. Like William Penn, who established his *sylvania* as a new land where he might hold his Quaker beliefs away from England's oppression, the Moravians also were seeking refuge from persecution.

The early Moravians were industrious. Their first building, the Gemein Haus (community house) was completed in 1741. This building still stands today, one of thirty-nine remarkably preserved pre-Revolutionary War buildings constructed by the Moravian settlers and in continuous use ever since by the Moravian community. These buildings are located on East Church St., west of the City Center; industrial buildings are located in the 18th Century Industrial Quarter in the Monocacy Creek valley behind Hotel Bethlehem.

The leader of the Moravians was Count Nicholas von Zinzendorf of Dresden. He arrived in the settlement in time for their observance of Christmas Eve in 1741; hence the name Bethlehem.

The settlers built high-quality structures of stone, demonstrating principles of engineering that were not generally used elsewhere. But their principal interest was music, and they established the first symphony orchestra in America. In 1748, the settlement had a fourteen-man orchestra. The community's first organ was built in 1757 by John Gottlob Klemm. The musical tradition, including the trombone choir, continues today, perhaps most visibly in the Bach Choir of Bethlehem, whose yearly Bach Festival is held in the university's Packer Memorial Church.

Music hath charms... It is said that hostile Indians during the 1750s planned a night attack on one occasion, but the sweet music of hymns emanating into the silence of the night frightened off the invaders, who supposedly thought some godlike power protected the community.

Zinzendorf envisioned Bethlehem as the center for manufacturing; outlying Moravian settlements, such as Nazareth, Pa., would be primarily devoted to agriculture. On October 15, 1742, a large barn was "raised" with the help of most of the residents. Three months later a grist mill at the community spring produced the first flour. In 1758, the Sun Inn was built along Main St., a haven for travelers to the industrial community. Reconstruction of the inn was completed in 1982, and the building now operate as a community center and dining facility.

Zinzendorf's determination that Bethlehem would be a major industrial center was greatly assisted by the completion in 1755 of the water works, the first public utility in the New World. The structure is located in the Industrial Quarter.

The Moravian dedication to education was an extension of the philosophy of Amos Comenius, who had written, "Everyone ought to receive a universal education." The several Moravian educational institutions that continue today, including Moravian College, stem from this tradition.

The Moravians did not share dialects with the other Pennsylvania Germans. They spoke, as one early observer phrased it, "the most correct German of which America can boast."

The Moravians, although avowedly opposed to war, found their community transformed into a hospital when Washington's troops bivouaced at Valley Forge during the 1776-78 period. Benjamin Franklin, writing to the governor from Bethlehem, said: "We found this place filled with refugees, the workmen's shops and even cellars being crowded with women and children..." Washington came to the community once, and many other Continental Army officers were visitors.

The Sun Inn was also used as a hospital during the war; among its patients was an aristocractic renegade from France, Marie Joseph Paul Ives Gilbert Motier, the Marquis de la Fayette. Lafayette had come to assist the Continental Army aboard his own ship, the "Victory." Fifty years later a college in Easton was named in his honor and it became Lehigh's traditional football rival.

The first bridge across the Lehigh River was built in 1794, at cost of $8,000. It was replaced by another bridge in 1816, but the latter was destroyed by a flood in 1841. In 1759, the turnpike (toll road) over South Mountain, generally along the route of the present Wyandotte St. hill, was opened.

"Black gold." During the late 18th Century, anthracite was found in the Lehigh Valley. In 1818, the Lehigh Coal Co. and the Lehigh Navigation Co. were formed, one to mine the anthracite on the upper Lehigh River, the other to transport it downriver to Philadelphia and other metropolitan markets. Asa Packer and others who would be associated with Lehigh University were prime movers in this transportation effort.

The Lehigh River was difficult to navigate. Consequently, in 1829 the Lehigh Canal was completed from Asa Packer's hometown at Mauch Chunk (now Jim Thorpe), through Bethlehem, to Easton, where it connected with the Delaware Canal. During this period

Bethlehem was involved in light manufacturing, such as paper box making, comb-making, and trade in musical instruments. There was also a small iron foundry. During the 1840s, iron mines were opened in the area, and several blast furnaces, fueled by the easily accessible coal, were in operation. Zinc ore was found in neighboring Upper Saucon Township. These origins eventually led to the steel and zinc production that characterizes the Lehigh Valley today.

When Asa Packer founded Lehigh University in 1865, one of his objectives was to make possible broadly based education for young people of the region, combining the technical skills needed to run the flourishing industry of the Lehigh Valley.

In addition to its role as a steel-making center, Bethlehem today is a major tourist attraction during the holiday period. The Moravian community sets up an elaborate putz (nativity scene) and the entire city is decorated with Christmas lighting. The Moravian tradition of a single candle (now electric) in each window is widely observed.

Atop South Mountain is a steel tower known as the Star of Bethlehem. During the Christmas period, the star's hundreds of bulbs create a 95-foot-high star that can be seen for many miles. The star was the gift to the community of Marion Brown Grace, wife of Eugene Gifford Grace, the steel magnate and president of the university board of trustees for 32 years.

The community of Bethlehem has a population of approximately 78,000 persons with segments from a variety of nations who retain many of the traditions of their country of origin.

Bethlehem's principal employer is Bethlehem Steel Corp. The steel corporation maintains a major manufacturing facility and its corporate headquarters in Bethlehem. Its Homer Research Laboratories, costing $50 million and employing approximately eight-hundred persons, adjoins the Lehigh campus at the top of South Mountain. A number of high-technology firms also operate in the Lehigh Valley, most notably Air Products and Chemicals, Inc.

There are five independent colleges in the Lehigh Valley besides Lehigh. They are Lafayette, Allentown College of St. Francis de Sales, Moravian, Muhlenberg, and Cedar Crest. A cooperative program is maintained among the colleges. There are also two community colleges in the area.

Routes to Bethlehem

Bethlehem, hometown of the university, is accessible by bus, plane, train, or automobile. Public transportation is good.

Those who drive from major mid-Atlantic metropolitan areas can do so with a minimum of travel time. Bethlehem is sixty miles from Philadelphia and ninety miles from New York City.

Driving from New York and northern New Jersey. Take Route 22 west and leave at the third Bethlehem exit, Route 378. Continue on Route 378 south for 3.6 miles and when you cross the bridge over the Lehigh River, be careful to stay in the left lane. Turn left at the traffic light at the far end of the bridge; continue one block to the traffic light at Brodhead Ave., and turn right. Continue approximately three blocks until you see a parking lot on your right. You are welcome to park in this lot and then walk about half a block up the hill and across Brodhead Ave. to the Alumni Memorial Building, home of the office of admission and administrative offices. There are a limited number of parking spaces immediately adjoining the Alumni Memorial Building.

Driving from western Pennsylvania. Take Route 22 east, exiting at Route 378, which is the first Bethlehem exit. Continue south as described above.

From Philadelphia and southern New Jersey. Take Route 309 (Bethlehem Pike) north to Center Valley. Turn right onto Route 378 and go over the first mountain you see. About halfway down the far side of the mountain (after a total of 5.4 miles on Route 378), turn right onto Summit St. Continue for about two blocks, to the point where Summit St. concludes at Brodhead Ave. The university is directly ahead. Continue down Brodhead just beyond Packer Ave. and park in the visitor lot on your left.

An alternative for those traveling from southerly points is to take the Northeast Extension of the Pennsylvania Turnpike north to Exit 32, then head east towards Quakertown on Route 663 for three and a half miles. Turn left onto Route 309 (West End Boulevard) and continue as described above.

By bus and plane. Buses are available from New York City and Philadelphia. Allentown-Bethlehem-Easton Airport, north of Route 22, is served by Eastern and United airlines, USAir and Altair and Suburban commuter flights. A bus depot is located two blocks below campus, at Brodhead Ave. and Third St.

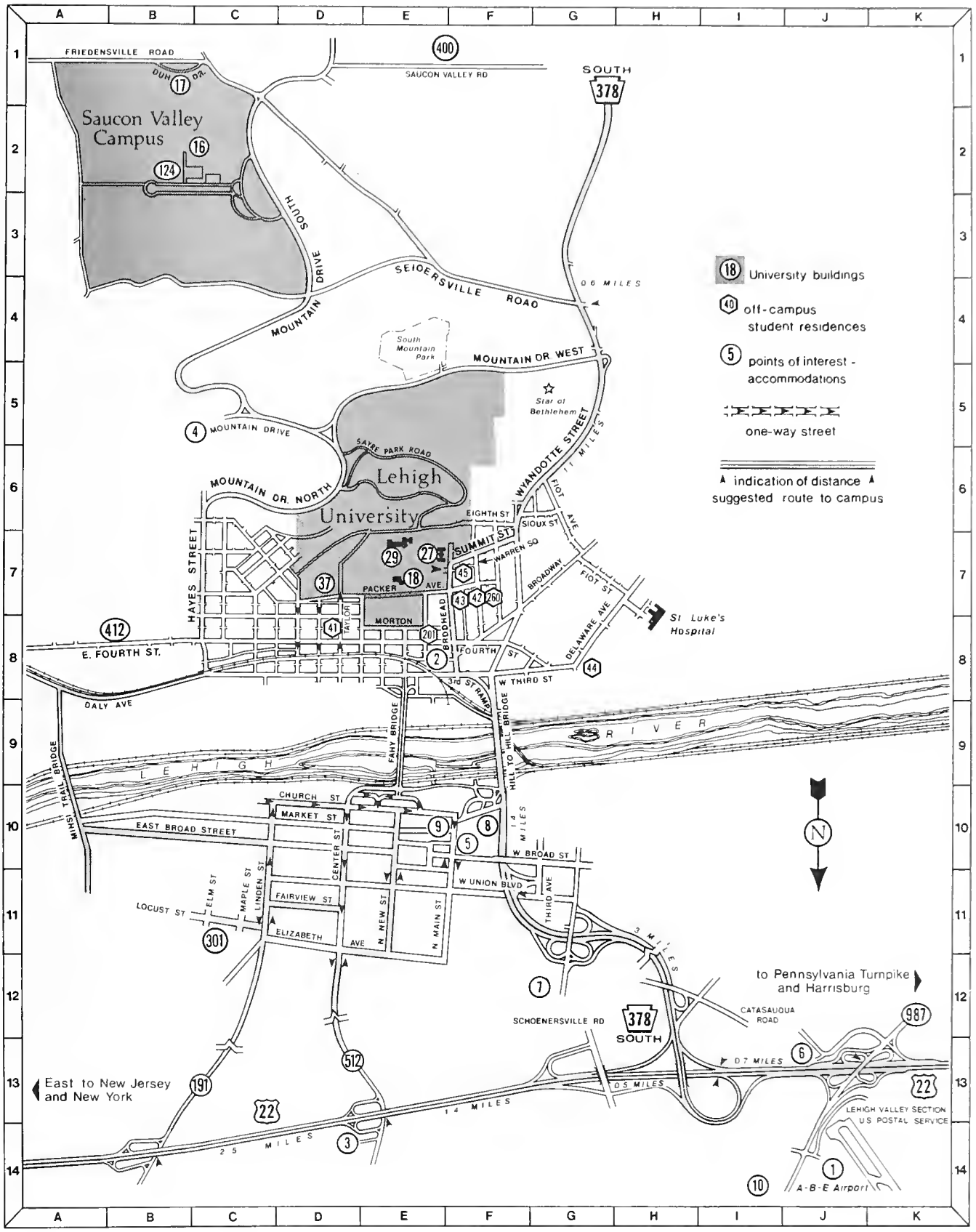
Lehigh University

South is at the top of the map.

260	Alpha Epsilon Pi
27	Alumni Memorial Building, admission and administration
124	Stabler Athletic and Convocation Center
201	Brodhead House
14	Centennial Building
42	Delta Chi, 233 W. Packer Ave.
43	Delta Sigma Phi, 217 W. Packer Ave.
44	Pi Kappa Alpha, 515 Delaware Ave.
18	Packer Memorial Church
41	Polk Gardens Apartments
16	Philip Rauch Field House
17	Saucon Married and Graduate Students Apartments
17	Sororities: Alpha Phi, Alpha Gamma Delta and Gamma Phi Beta
124	Stabler Athletic and Convocation Center
45	Tau Epsilon Phi, 227 Warren Square
37	Taylor Stadium
29	University Center
15	Varsity House

Bethlehem Points of Interest

19	ABE Airport
20	Bethlehem Bus Terminal
9	Bethlehem Plaza and The Marketplace
10	Bethlehem Steel Corp., offices and plant
8	City Center, administration, library, police
1	Holiday Inn—East
11	Homer Research Laboratories, Bethlehem Steel Corp.
5	Hotel Bethlehem
2	Howard Johnson Motor Lodge
3	Martin Tower, 24-story corporate headquarters, Bethlehem Steel Corp.
6	Monocacy Creek historic area
7	Moravian historic area
4	Moravian House apartments
12	Fred B. Rooney senior citizen apartment
21	Sheraton Jetport
13	WLVT-TV studios channel 39


FRIEDENSVILLE ROAD
DUH DR.
17
400
SAUCON VALLEY RD
SOUTH
378
Saucon Valley Campus
16
124
SOUTH DRIVE
SEIDERSVILLE ROAD
0.6 MILES
MOUNTAIN
South Mountain Park
MOUNTAIN DR WEST
Star of Bethlehem
4 MOUNTAIN DRIVE
SAYRE PARK ROAD
MOUNTAIN DR. NORTH
Lehigh University
WYANDOTTE STREET
1.1 MILES
EIGHTH ST
SIOUX ST
SUMMIT ST
WARREN SQ
HAYES STREET
29
27
37
18
PACKER AVE.
46
43
42
260
BROADWAY
FIOT ST
TAYLOR
MORTON
BROTHEAD
201
DELAWARE AVE
St Luke's Hospital
412
E. FOURTH ST.
2
FOURTH ST
44
W THIRD ST
37th ST RAMP
DALY AVE
FAHY BRIDGE
HILL TO HILL BRIDGE
MIHS TRAIL BRIDGE
L E H I G H
R I V E R
CHURCH ST
MARKET ST
EAST BROAD STREET
9
8
5
1.4 MILES
W BROAD ST
W UNION BLVD
CENTER ST
ELM ST
MAPLE ST
LINDEN ST
FAIRVIEW ST
N NEW ST
N MAIN ST
THIRD AVE
LOCUST ST
ELIZABETH AVE
301
3 MILES
7
SCHOENERSVILLE RD
378
SOUTH
CATASAUQUA ROAD
987
0.7 MILES
6
0.5 MILES
22
LEHIGH VALLEY SECTION U.S. POSTAL SERVICE
512
191
East to New Jersey and New York
22
1.4 MILES
2.5 MILES
3
10
1
A-B-E Airport
to Pennsylvania Turnpike and Harrisburg
N
18 University buildings
40 off-campus student residences
5 points of interest - accommodations
one-way street
indication of distance
suggested route to campus

The South Mountain Campus

University Buildings

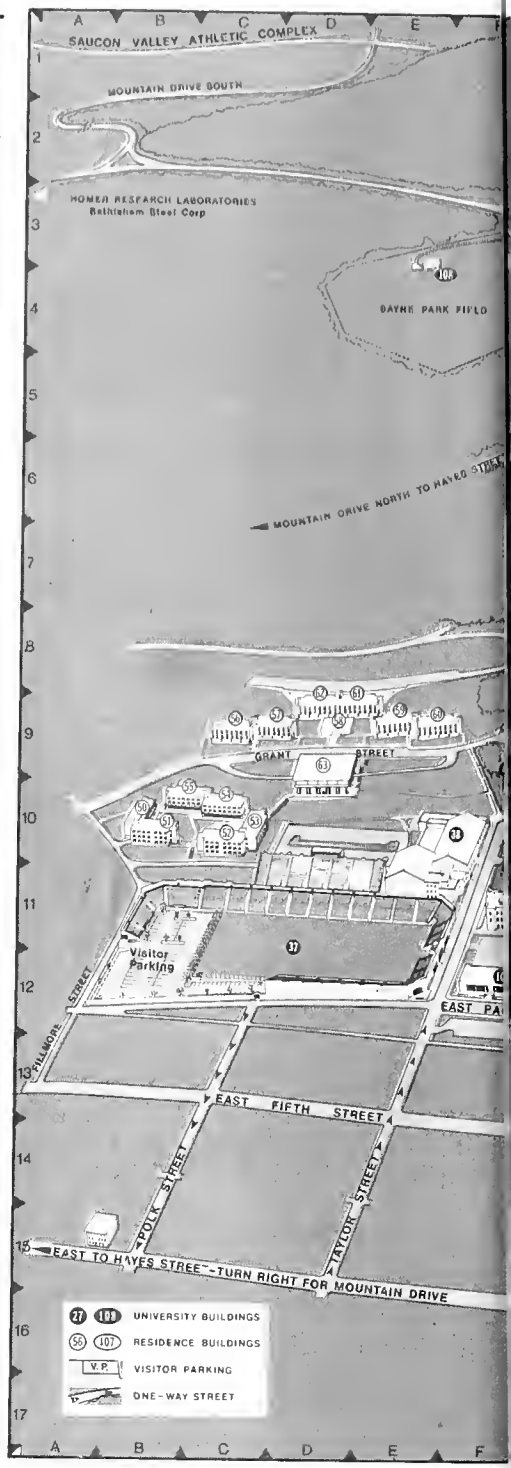
The South Mountain Campus encompasses approximately 200 acres. South is at the top of the map, north at the bottom.

27 Alumni Memorial Building (admission, administration, alumni association) O-10
14 Career planning and placement services (Christmas-Saucon Hall) J-12
10 Central Heating and Refrigeration F-12
17 Chandler-Ullmann Hall I-10
6A Chemistry auditoriums J-12
14 Christmas-Saucon Hall and Annex J-12
9 College of Arts and Science (Maginnes Hall) M-13
35 College of Business and Economics (Drown Hall) K-8
19 College of Engineering and Physical Sciences (Packard Laboratory) M-11
197 Computing Center administration, 616 Brodhead Avenue (central computing facilities, Packard Laboratory) Q-10
26 Continuing Education (Sayre Building) P-10
33 Coppee Hall J-9
32 Coxe Laboratory I-9
35 Drown Hall K-8
3 Facilities services and physical plant G-12
2 Figlear Building L-15
36 Fraternity Management Association (Johnson Hall) L-8
13 Fritz Engineering Laboratory I-11
11 Fritz Laboratory Annex H-12
39 Grace Hall G-9
5 Graduate School office (Whitaker Laboratory) I-13
36 Johnson Hall (health services, counseling service) L-8
34 Lamberton Hall J-8
30 Linderman Library J-9
9 Maginnes Hall M-13
8 Mart Science and Engineering Library K-13
6A Neville Hall J-12
41 Newman Association Center F-9
19 Packard Laboratory M-11
18 Packer Memorial Church K-11
199 Personnel Office, 622 Brodhead Avenue Q-9
15 Philosophy Building L-12
3A Physical Planning Office G-12
16 Physics Building G-11
28 President's House N-9
40 Price Hall G-8
189 Public Information Office, 434-436 Brodhead Ave. Q-11
202 Purchasing office, 404 Adams St. I-15
63 Rathbone Hall dining facility D-9
63 Residence Operations (Rathbone Hall, lower level) D-9
26 Sayre Building (Continuing Education) P-10
23 School of Education, 516-524 Brodhead Avenue QR-11
6 Seeley G. Mudd Building I-12
1 Service Building H-16
161 Sherman Fairchild Laboratory for Solid-State Studies H-10
7 Sinclair Laboratory J-13
203 Small Business Center, 412 S. New Street M-15
194 Special Education Building, 216 West Packer Avenue R-11
195 Summer Sessions Office, 219 Warren Square S-11
38 Taylor Gymnasium and Field House F-10
37 Taylor Stadium CDE-11
24 Town House Q-10
29 University Center L-9
29 University Police headquarters (University Center) L-9
5 Whitaker Laboratory I-13
12 Wilbur Drama Workshop G-11
31 Williams Hall 11-10

Research and Academic Centers and Institutes

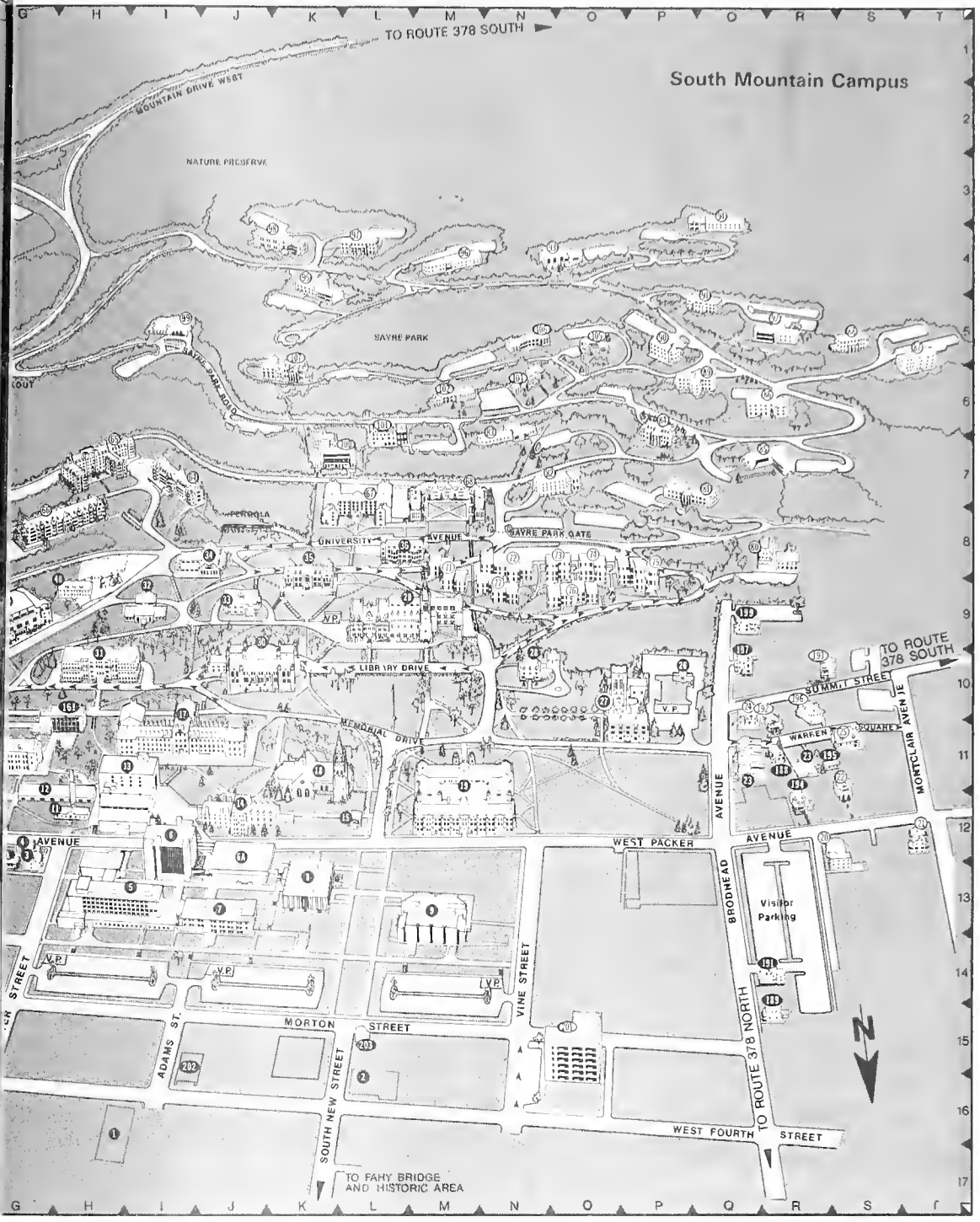
5 Biotechnology Research Center (Whitaker Laboratory I-13
2 Center for the Application of Mathematics, Figlear Building L-15; director's office, Linderman J-10
36 Center for Economic Education (Johnson Hall) L-8
17 Center for Health Sciences (Chandler-Ullmann Hall) I-10
8 Center for Information and Computer Science (Mart Library) K-13
31 Center for Marine and Environmental Studies (Chandler-Ullmann) I-10
2 Center for Social Research (Figlear Building) L-15
7 Center for Surface and Coatings Research (Sinclair Laboratory) J-13
191 Computing Center (Packard Laboratory) M-11
7 Emulsion Polymers Institute (Sinclair Laboratory) J-13
191 Energy Research Center, 440 Brodhead Ave. R-14
35 Fairchild-Martindale Center for the Study of Private Enterprise (Drown Hall) K-8
13 Fritz Engineering Laboratory I-11
30 Institute for Fracture and Solid Mechanics (Packard Laboratory) M-11
5 Institute for Metal Forming (Whitaker Laboratory) I-13
23 Institute for Research and Development in Education, 520 Brodhead Ave. Q-11
19 Institute for Robotics (Packard Laboratory) M-11
19 Institute for Thermo-Fluid Engineering and Science (Packard Laboratory) M-11
35 Kachel Commodities Institute (Drown Hall) K-8
9 Lawrence Henry Gipson Institute for Eighteenth-Century Studies (Maginnes Hall) M-13
32 Materials Research Center (Coxe Laboratory) I-9
7 National Printing Ink Research Institute (Sinclair Laboratory) J-13
4 Office of Research, 203 E. Packer Ave. G-12
35 Rauch Center for Executive Development (Drown Hall) K-8
161 Sherman Fairchild Laboratory for Solid-State Studies H-10
203 Small Business Development Center, 412 S. New St. M-15

The Wetlands Institute, Stone Harbor, N.J.



Residential Buildings

201 Brodhead House O-15
55 Beardslee House C-10
54 Carothers House C-10
56-62 Centennial I houses D-8
50-55 Centennial II houses B-9
56 Congdon House C-9
65 Dravo House H-7
64 Drinker House I-7
57 Emery House D-9
193 French/Spanish House (Warren Square D), 222-224 Summit St. R-10
192 German House (Warren Square B), 210-121 Warren Square R-10
89 Hill House Q-6
Hillel House, 214 Summit St. R-10
196 International House (Warren Square A), 220-222 Warren Square R-10

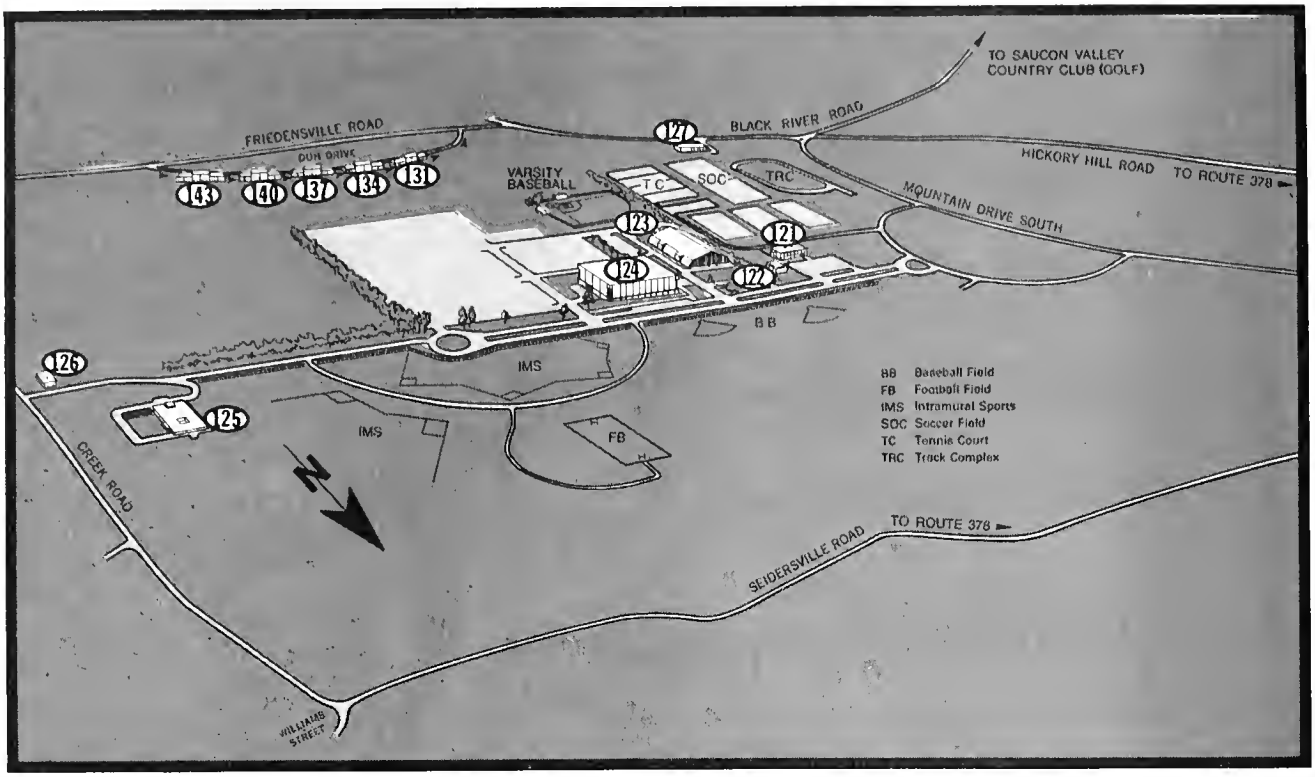


Fraternity Residences

62 Leavitt House D-8
67 McClintic-Marshall House L-7
61 McConn House E-8
53 Palmer House C-10
Polk Gardens apartments, 4th and Polk Sts. A-15
66 Richards House G-8
59 Smiley House E-9
52 Stevens House C-10
51 Stoughton House B-10
68 Taylor House M-7
60 Thornburg House E-9
71-77 Trembley Park student apartments N-9
24 Warren Square C, 532-534 Brodhead Ave. Q-10
103 Warren Square D, 222-224 Summit St. P-10
50 Williams House B-10

93 Alpha Chi Rho O-4
Alpha Epsilon Pi, 308 W. Packer Ave. I-12
106 Alpha Sigma Phi N-5
99 Alpha Tau Omega I-5
83 Beta Theta Pi N-6
105 Chi Phi O-5
84 Chi Psi P-6
21 Delta Chi, 233 W. Packer Ave. T-12
22 Delta Chi Annex, 230 W. Packer Ave. S-11
86 Delta Phi R-6
20 Delta Sigma Phi, 217 W. Packer Ave. S-11
81 Delta Upsilon Q-7
85 Kappa Alpha R-7
87 Kappa Sigma T-5
97 Lambda Chi Alpha L-4
101 Phi Delta Theta L-6

104 Phi Gamma Delta N-6
88 Phi Kappa Theta S-5
90 Phi Sigma Kappa P-5
Pi Kappa Alpha, 515 Delaware Ave.
98 Pi Lambda Phi K-4
80 Psi Upsilon R-8
94 Sigma Alpha Mu Q-3
102 Sigma Chi M-6
82 Sigma Nu O-7
100 Sigma Phi L-7
92 Sigma Phi Epsilon R-5
25 Tau Epsilon Phi, 227-229 Warren Square S-11; annex, 216 Warren Square
91 Theta Chi Q-4
107 Theta Delta Chi K-5
96 Theta Xi M-4
95 Zeta Psi K-4



Saucon Valley Complex

Lehigh's Saucon Valley athletic complex, located in the area just to the south of the main South Mountain campus, encompasses some 600 acres. Numerous athletic fields and tennis courts are located on the site. South is at the top of the map.

The university's Saucon Valley athletic complex affords a variety of facilities for sports participation and competition, as well as the major arena in the Lehigh Valley for performances and athletic competition. From the main campus, continue up the hill on the campus road in front of the Alumni Memorial Building. Continue ahead around the contemporary-style Trembley Park student apartment complex. Stop at the first stop sign, then proceed to the second stop sign, located at the entrance to Sayre Park. Turn into Sayre Park and continue to the right, through the fraternity neighborhood.

If you want to stop at the Lookout, affording a view over the Lehigh Valley to the foothills of the Poconos, turn left at the traffic island. The upper road continues to the right. Both roads conclude at Mountain Drive, but at different places. Turn right onto Mountain Drive and proceed left at the first fork. The Bethlehem Steel Corp. research laboratories are on your left, but continue across and down the mountain to the stop sign at the foot of the other side. The entrance to the Saucon Valley athletic complex is just ahead.

During the summer, when Sayre Park is closed, take Route 378 south to the top of the mountain and enter the jughandle there to turn left onto Mountain Drive. Proceed on Mountain Drive east and then south, until you reach the stop sign at the bottom of the south slope. The Saucon Valley complex entrance is just ahead.

If you are coming in from the south, take Route 378 north from Route 309 at Center Valley. Just before you reach the upgrade for South Mountain, you will see signs directing you to the Stabler Arena and the Saucon complex. A right turn will be required.

125	Centennial Building
127	Field Shop maintenance facility
123	Philip Rauch Field House
131-143	Saucon Married and Graduate Students Apartments (SMAGS):
143	Diamond
140	Gipson
137	Hartman
134	More
131	Severs
137	Alpha Gamma Delta sorority
140	Alpha Pi sorority
134	Gamma Phi Beta sorority
122	Squash Court Building
124	Stabler Athletic and Convocation Center
126	Transportation Services Building
121	Varsity House locker facility

VII

Administration, Faculty, and Staff

This section lists the people whose talents and abilities constitute the university's most important resource. Members of the board of trustees contribute their expertise to establish the policies of the university. Also listed are the administration, members of the faculty and staff, and the members of the visiting committees who help to keep courses of instruction current and of maximum value to the students and prospective employers.

Board of Trustees

When the year of the degree is listed, the degree was awarded by Lehigh University.

Officers of the Board

Harold S. Mohler, president
John W. Woltjen, secretary and treasurer
Paul J. Franz, Jr., assistant secretary
Elmer W. Glick, honorary secretary

Corporate Members

William B. Eagleson, Jr., B.S. '49, M.B.A., Malvern, Pa., chairman and chief executive officer, Girard Bank, Philadelphia

Edwin H. Gott, B.S. '29, LL.D., Pittsburgh, Pa., retired chairman, United States Steel Corp.

William C. Hittinger, B.S. '44, Eng.D. '73, Summit, N.J., executive vice president, research and engineering, RCA Corp.

Walter S. Holmes, Jr., B.S. '41, M.B.A., Glen Ridge, N.J., chief executive officer and chairman, C.I.T. Financial Corp.

Harold S. Mohler, B.S. '48, LL.D. '75, Hershey, Pa., chairman of the board, Hershey Foods Corp.

Kirk P. Pendleton, B.A. '63, B.S. '64, Huntingdon Valley, Pa., chairman of the board, Pitcairn, Inc.

Frank C. Rabold, B.S. '39, Eng.D '70, Saylorsburg, Pa., retired manager of corporate services, Bethlehem Steel Corp.

Richard M. Smith, B.S. '48, Bethlehem, Pa., vice chairman, Bethlehem Steel Corp.

Donald B. Stabler, B.S. '30, M.S. '32, LL.D. '74, Harrisburg, Pa., chairman, Stabler Companies, Inc.

The Rt. Rev. Dean T. Stevenson, B.A. '37, S.T.B., M.A. '49, D.D., Harrisburg, Pa., retired bishop of the Episcopal Diocese of Central Pennsylvania.

Appointed Trustees

Dexter F. Baker, B.S. '50, M.B.A. '57, Allentown, Pa., president, Air Products and Chemicals, Inc.

Philip J. Berg, B.S. in M.E. '44, Sewickley, Pa., executive vice president, Dravo Corp.

John D. Cullen, B.A. '48, B.S. '49, M.S., Wilmington, Del., vice president and chief engineer, E.I. du Pont de Nemours & Co.

Theodore L. Diamond, B.A., '37, M.B.A., New York City, president, T.L. Diamond Co., Inc.

William O. Fleckenstein, '49, Colts Neck, N.J., vice president, Bell Telephone Laboratories, Inc.

Murray H. Goodman, B.S. '48, chairman, The Goodman Group, Palm Beach, Fla.

Milton H. Grannatt, Jr., B.S. '39, Trenton, N.J., president, Fell & Moon Co.

Nancy M. Kissinger, B.A., M.A., L.H.D. '77, Washington, D.C.

Stanley M. Richman, B.S. '55, Short Hills, N.J., vice president, Lightning Electric Co.

Edwin F. Scheetz, Jr., B.S. '54, Pittsburgh, Pa., managing director, Blyth Eastman Paine Webber Inc.

Edward G. Uhl, B.S. '40, Sc.D. '75, Germantown, Md., chairman of the board and chief executive officer, Fairchild Industries

Members Elected by Alumni

William L. Clayton, B.S. '51, Short Hills, N.J., executive vice president, E.F. Hutton & Co.

Samuel W. Croll, Jr., B.S. '48, Chatham, N.J., retired president, Croll-Reynolds Co., Inc.

James J. Duane, III, B.A. '73, M.A. '75, LL.B. '78, Boston, attorney, Powers and Hall

Robert H. Hicks, Jr., B.S. in M.E. '44, Baltimore, retired

Thomas E. Hirsch, III, B.A. '75, Washington, D.C., acting deputy, Federal Energy Regulatory Commission

Augustus A. Riemondy, '41, Hershey, Pa., retired

Robert H. Riley, Jr., B.S. '35, Towson, Md., consultant, Black and Decker, Inc.

C. Keith Rust, '57, Bethlehem, Pa., president, Roland and Roland, Inc.

Honorary Trustees

Alfred G. Blake, '24, C.E. '25, Plainfield, N.J., retired chairman of the board, Engelhard Minerals and Chemicals Corp.

Malcolm Carrington, Jr., B.S. '39, Livingston, N.J., retired vice president and secretary, Public Service Electric and Gas Co.

Morgan J. Cramer, '28, Fountain Hills, Ariz., retired president, P. Lorillard and Co.

Lee A. Iacocca, B.S. '45, M.S., LL.D., Eng.D. '69, Bloomfield Hills, Mich., chairman, Chrysler Corp.

Edmund F. Martin, B.S., Eng.D., LL.D., LL.D. '66, Bethlehem, Pa., retired chairman of the board and chief executive officer, Bethlehem Steel Corp.

S. Murray Rust, Jr., B.S. in M.E. '34, Orleans, Mass. retired chairman of the board, Rust Engineering Co.

Members Emeriti

Edward A. Curtis, '25, B.S. in Bus. Ad. '26, LL.D. '62, Doylestown, Pa., retired vice president, New Jersey Bell Telephone Co.

Allen C. DuBois, B.A. '25, LL.D. '69, Delray Beach, Fla., retired partner, Wertheim & Co.

C. Lester Hogan, B.S. M.S. '47, Ph.D. '50, A.M., Eng.D., D.Sc., Eng.D. '71, Atherton, Calif., consultant to the president, Fairchild Camera and Instrument Corp.

Leonard M. Horton, B.S. in Bus. Ad. '28, LL.D. '65, Short Hills, N.J., retired chairman of the board, Aubrey G. Lanston & Co., Inc.

Kenneth L. Isaacs, M.E. '25, LL.D., '65, Boston, retired consultant, Massachusetts Financial Services, Inc.

Frank L. Magee, E.E. '17, Eng.D. '56, Stahlstown, Pa., retired chairman of the executive committee, Aluminum Company of America

Hugh P. McFadden, B.S. '25, LL.D. '67, Hellertown, Pa., attorney in private practice

Ivor D. Sims, B.S. in Bus. Ad. '33, LL.D. '70, Bethlehem, Pa., retired executive vice president, Bethlehem Steel Corp.

Edwin H. Snyder, E.E. '23, Eng.D '68, Summit, N.J., retired chairman of the board, Public Service Electric and Gas Co.

Committees of the Board

Executive committee. Mr. Mohler, chairman; Mr. Stabler, first vice chairman; Mr. Curtis, second vice chairman; Messrs. Rabold and Pendleton, members.

Physical planning and plant committee. Mr. Rabold, chairman; Mr. Curtis, honorary chairman; the Messrs. Jerome Barney, Goodman, Gott, Grannatt, Hicks, and Stabler, members.

Committee on finance and investments. Mr. Smith, chairman; the Messrs. Walter W. Buckley, Jr., Clayton, Eagleson, Holmes, and Pendleton, members.

Development committee. Mr. Stabler, chairman; the Messrs. Eagleson, Gott, Holmes, Philip Rauch, Smith, and George G. Zipf, members.

Committee on bequests and trusts. Mr. Eagleson, chairman; Mr. Blake, Jeanne Conley, and the Messrs. John K. Killmer, Jacob S. Kolb, Robert H. Littner, John B. O'Hara, William J. Scarlett, III, Richard W. Shaffer, and Robert W. Worley, members.

Committee for visiting committees. Mr. Stabler, chairman; the Messrs. Baker, Pendleton, and Uhl, members.

Audit committee. Mr. Holmes, chairman; the Messrs. Baker, Carrington, O'Hara, and Scheetz, members.

Succession committee. Mr. Mohler, chairman; the Messrs. Hittinger, Pendleton, and Smith, and the Rt. Rev. Dr. Stevenson, members.

Research committee. Mr. Hittinger, chairman; the Messrs. Berg, Fleckenstein, and Uhl, members.

The Visiting Committees

The university is eager to strengthen fruitful communication with the society it serves, and that desire motivated the establishment of visiting committees of the board of trustees.

These committees annually bring to the university representatives of industry, government, and education who study those areas of the university which they are most competent to judge, and report periodically on their evaluation of those areas.

Members of the board of trustees often serve as chairmen of visiting committees. In most cases, the first member listed is the chairman.

Those who are Lehigh alumni are indicated by the inclusion of their class year.

Art and Architecture

S. Murray Rust, Jr., '35, retired chairman, Rust Engineering Co.

John Coolidge, department of fine arts, Fogg Museum, Harvard University

J.B. Jones, associate, The Architects Collaborative, Inc.

Dorothy Gillespie, director, Art in the Community Institute, New School for Social Research

College of Arts and Science

Kirk P. Pendleton, '63, chairman of the board, Pitcairn, Inc.

S. Murray Rust, Jr., '35, retired chairman, Rust Engineering Co.

Francis H. Spiegel, '57, vice president, corporate planning, Merck & Co., Inc.

The Very Rev. Dr. Daniel Gambet, O.S.F.S., president, Allentown College of St. Francis de Sales

William L. Clayton, '51, executive vice president, E.F. Hutton & Co.

Donald B. Stabler, '30, chairman, Stabler Companies, Inc.

Brig. Gen. Augustus A. Riemondy, USAF (ret.), '41

James J. Duane, III, '73, attorney, Powers and Hall, P.C.

Nancy M. Kissinger, '77 (hon.)

John Heiss, '60

Edwin F. Scheetz, Jr., '54, managing director, Blyth Eastman Paine Webber Inc.

Milton H. Grannatt, Jr., '39, president, Fell and Moon Co.

Samuel W. Croll, Jr., '48, retired

Oldrich Foucek, III, '72, Butz, Hudders and Tallman

Irvin Feld, '76 (hon.), president, Ringling Brothers and Barnum and Bailey Combined Shows, Inc.

Intercollegiate Athletics

C. Keith Rust, '57, president, Roland and Roland, Inc.

Edward N. Cahn, '55, federal court judge

Samuel W. Croll, Jr., '48, retired

Samuel C. Howell, associate director of athletics, Princeton University

Curtis F. Bayer, '35, honorary member, retired vice president, Erie Lackawanna Railroad

Edward A. Curtis, '25, honorary member, retired vice president, New Jersey Bell Telephone Co.

Joseph M. Workman, '53, manager, marketing research-sales, Bethlehem Steel Corp.

Lee A. Butz, '55, president, Alvin H. Butz, Inc.

Biology

Francis H. Spiegel, '57, vice president, corporate planning, Merck & Co., Inc.

Dr. Ruth Patrick, senior curator, division of limnology and ecology, Academy of Natural Sciences

Robert Saydah, '49, general manager, Lederle Laboratory and Pharmaceutical Division of American Cyanamid Co.

Samuel G. Siris, M.D. '67, physician and psychiatrist, Mount Sinai Hospital

Frank J. Vernberg, Baruch professor of marine biology, Baruch Coastal Research Institute, University of South Carolina

Douglass H. Morse, Hermon Carey Bumpus professor of biology, Brown University

College of Business and Economics

William L. Clayton, '51, executive vice president, E.F. Hutton & Co.

Richard M. Smith, '48, vice chairman, Bethlehem Steel Corp.

Thomas F. Keller, dean, Fuqua School of Business, Duke University

Eugene Mercy, Jr., '59, partner, Goldman Sachs and Co.

Philip R. Peller, '60, partner, Arthur Andersen & Co.

Philip Rauch, '33, chairman, executive committee, Parker Hannifin Corp.

Lunsford Richardson, Jr., '46, director, Richardson-Vicks

Chemical Engineering

Dexter F. Baker, '50, president, Air Products and Chemicals, Inc.

Lowell B. Koppel, head, department of chemical engineering, Purdue University

W. James Porter, '52, vice president, chemical technology department, Exxon Chemical Co.

Roger A. Schmitz, dean of engineering, University of Notre Dame

William R. Schowalter, chairman, department of chemical engineering, Princeton University

Kenneth A. Smith, '67, associate provost, Massachusetts Institute of Technology

Chemistry

John D. Cullen, '48, vice president and chief engineer, E.I. du Pont de Nemours & Co.

Tomlinson Fort, Jr., vice president, academic affairs, California Polytechnic State University

David M. Hercules, department of chemistry, University of Pittsburgh

Irving D. Isko, president and chief executive officer, Engelhard Corp.

James F. Roth, corporate chief scientist and director, Corporate Science Center, Air Products and Chemicals, Inc.

Lewis Friedman, '43, senior chemist, Brookhaven National Laboratory, Associated Universities, Inc.

Morton K. Schwartz, '48, chairman, department of clinical chemistry, Memorial Sloane Kettering Cancer Center

Civil Engineering and Fritz Engineering Laboratory

Philip J. Berg, '44, executive vice president, Dravo Corp.

Gerard A. Rohlich, C.W. Cook professor, department of civil engineering, University of Texas at Austin

Charles Scheffey, office of research and development, Federal Highway Administration

Larry J. Feeser, '58, chairman, department of civil engineering, Rensselaer Polytechnic Institute

John F. Kennedy, director and professor, Institute of Hydraulic Research, the State University of Iowa

Robert L. Smith, '44

Classics and Modern Foreign Languages and Literature

The Very Rev. Dr. Daniel G. Gambet, O.S.F.S., president, Allentown College of St. Francis de Sales

Helen F. North, department of classics, Swarthmore College

Curt A.C. Pedersen, director of engineering, Mack Trucks, Inc.

Ernest A. Scatton, professor, department of Slavic languages and literature, State University of New York

Gloria Flaherty, department of German, Bryn Mawr College

Frank Durand, associate provost, and professor of Hispanic studies, Brown University

Glen W. Bowersock, Institute for Advanced Study

Computing Center

Thomas H. Crowley, executive director, computing technology and design engineering, Bell Telephone Laboratories

Weston J. Burner, director, information processing services, Massachusetts Institute of Technology

Fred H. Harris, director, computation center, University of Chicago

James L. Moss, director, office of computer services, Rensselaer Polytechnic Institute

School of Education

Frank C. Rabold, '39, retired

Jack MacDonald, president, Motors Insurance Co.

Philip H. Mann, School of Continuing Studies, University of Miami

William Smith, administrator, Overseas Dependent Schools, U.S. Department of Education

Donald E. Langlois, superintendent, West Chester School District, and adjunct professor, Lehigh University

Frank S. Manchester, executive director, Pennsylvania Association of Elementary and Secondary School Principals

Carolyn M. Stauffer, manager, information center, The Foundation for the Advancement of Computer-Aided Education

Thomas J. Sweeney, College of Education, Ohio University

Caryl M. Kline, educational consultant

Electrical and Computer Engineering

William O. Fleckenstein, '49, vice president, Bell Telephone Laboratories

Edward B. Eichelberger, '56, manager, design systems, IBM Corp.

Paul C. Ely, Jr., '53, vice president, computer systems group, Hewlett-Packard Corp.

Edwin H. Snyder, '23, honorary member, retired board chairman and chief executive officer, Public Service Electric and Gas Co.

David F. Barbe, assistant for electronics and physical sciences, Office of the Assistant Secretary of the Navy for Research Engineering and Systems

Lotfi A. Zadeh, computer science division, University of California

Jospeh F. Traub, Edwin Howard Armstrong professor and chairman, computer science department, Columbia University

Energy Research Center

Heinz Pfeiffer, manager, technology and energy assessment, Pennsylvania Power and Light Co.

Willem Vedder, manager, research and development planning, General Electric Co.

Alan Schriesheim, general manager, engineering technology department, Exxon Research and Engineering Co.

John O'Toole, vice president for nuclear, Consolidated Edison Corp., Inc.

Thomas E. Stelson, vice president of research, Georgia Institute of Technology

College of Engineering and Physical Sciences

William C. Hittinger, '44, executive vice president, research and engineering, RCA Corp.

Dexter F. Baker, '50, president, Air Products and Chemicals, Inc.

Philip J. Berg, '44, executive vice president, Dravo Corp.

John D. Cullen, '48, vice president and chief engineer, E.I. du Pont de Nemours & Co.

Edward G. Uhl, '41, chairman and chief executive officer, Fairchild Industries, Inc.

Robert H. Riley, '35, retired director of research, Black and Decker Manufacturing Co.

Everett H. Van Hoesen, '55, president, information records division, IBM Corp.

William O. Fleckenstein, '49, vice president, Bell Telephone Laboratories

English and Journalism

William L. Clayton, '51, executive vice president, E.F. Hutton & Co.

William A. Digel, '59, product information supervisor, marketing communications department, E.I. du Pont de Nemours and Co.

Joseph R.L. Sterne, '48, editor of the editorial page, *The Baltimore Sun*

James F. Dulicai, '64, senior staff adviser and editor, Mobil Oil Corp.

Victoria Weiss, '77-G, assistant professor, department of English, Oglethorpe University

Geological Sciences

Donald B. Stabler, '30, chairman, Stabler Companies, Inc.

Lawrence H. Lattman, dean, College of Mines and Minerals Industries, University of Utah

Siegfried J. Muessig, manager, mineral exploration, Getty Oil Co.

Leon T. Silver, division of geological and planetary sciences, California Institute of Technology

Richard B. Palmer, '43, executive-in-residence, Fuqua School of Business, Duke University

Robert I. Tilling, chief, Branch of Field Geochemistry and Petrology, U.S. Geological Survey

Government

Brig. Gen. Augustus A. Riemondy, USAF (ret.), '41, retired

Edward A. Curtis, '25, retired vice president, New Jersey Bell Telephone Co.

Maury B. Poscover, '66, partner, Husch, Eppenberger, Donohue, Elson and Cornfeld

Edgar L. Shor, department of political science, Colgate University

Edward P. Flood, '69-G, deputy managing director, City of Philadelphia

History

James J. Duane, III, '73, attorney, Power and Hall, P.C.

John Dufty, department of history, University of Maryland

Mary M. Dunn, professor, department of history, Bryn Mawr College

Brooke Hindle, senior historian, National Museum of History and Technology, Smithsonian Institution

Franklin J. Pegues, professor, department of history, Ohio State University

Otey M. Scruggs, professor, department of history, Syracuse University

John J. TePaske, professor, department of history, Duke University

Industrial Engineering

Everett H. Van Hoesen, '55, president, information records division, IBM Corp.

John R. MacLean, '51, senior vice president, Linde Division, Union Carbide Corp.

Benjamin W. Niebel, professor emeritus, Pennsylvania State University

Arnold O. Putman, '43, president, Rath and Strong, Inc.

William L. Westerman, '54, president, Cellu-Craft, Inc.

Center for Information and Computer Science

T.H. Crowley, executive director, Bell Telephone Laboratories

Melvin S. Day, director, National Technical Information Service

Frank L. Friedman, professor, computer and information science department, Temple University

Anthony Ralston, chairman, department of computer science, State University of New York at Buffalo

International Relations

Nancy M. Kissinger, '77 (Hon.)

Chun-Tu Hsueh, professor, department of government, University of Maryland

John A. Jordan, manager, financial planning, finance department, Bethlehem Steel Corp.

Joseph V. Montville, '59, special assistant to the director for policy assessments, U.S. Department of State

Kenneth W. Thompson, Commonwealth professor of government and foreign affairs, White Burkett Miller Center of Public Affairs, University of Virginia

Libraries

William B. Eagleson, Jr., '49, chairman and chief executive officer, Girard Bank

Connie Dunlap, director of libraries, Duke University

Laurence Fenninger, retired

Carlton Rochelle, director of libraries, New York University

Life Science Centers

Theodore L. Diamond, '37, president, T.L. Diamond & Co., Inc.

Robert B. Abel, president, New Jersey Marine Sciences Consortium

Dr. Peter J. Brueckner, Sunnybrook Medical Center, University of Toronto

Stephen W. Drew, director, biochemical engineering, Merck Sharpe & Dohme Co., Inc.

Rolf M. Huseby, vice president for research and development, J.T. Baker Instruments

Thomas M. Devlin, chairman, department of biological chemistry, The Hahnemann Medical College

Anthony F. Gaudy, chairman, civil engineering department, University of Delaware

Alonzo W. Lawrence, vice president for research and development, Koppers Corp.

Mathematics and Center for the Application of Mathematics

Kirk P. Pendleton, '63, chairman of the board, Pitcairn, Inc.

Richard DiPrima, chairman, department of mathematical sciences, Rensselaer Polytechnic Institute

Richard A. Toupin, director, IBM Corp.

Daniel H. Wagner, president, Daniel H. Wagner Associates

William Browder, professor, department of mathematics, Princeton University

Juris Hartmanis, professor, department of computer science, Cornell University

Paul R. Garabedian, professor, department of mathematics, Courant Institute, New York University

Mechanical Engineering and Mechanics

Robert H. Riley, '35, retired director of research, Black and Decker Manufacturing Co.

Norman D. Postma, executive engineer, Ford Motor Co.

William B. Cottingham, president, General Motors Institute

Richard E. Disbrow, '52, president, American Electric Power Service Corp.

Metallurgy and Materials Engineering and Materials Research Center

Harold D. Brody, chairman, department of metallurgical and materials engineering, University of Pittsburgh

Gilbert Y. Chin, head, physical metallurgy and ceramics development department, Bell Telephone Laboratories

James L. White, professor, polymer engineering, University of Tennessee

Joseph E. Burke, retired manager of special projects, General Electric Research and Development Center

Ralph C. Leinbach, Jr., '54, group vice president, Carpenter Steel Division, Carpenter Technology Corp.

William R. Prindle, director of administrative and technical services, Corning Glass Works

Darrell H. Reneker, deputy director, Center for Materials Science, U.S. Department of Commerce

Music

John Heiss, '60

Jameson Marvin, director, choral activities, department of music, Harvard University

Philosophy

Edwin F. Schoetz, Jr., '54, managing director, Blyth Eastman Paine Webber Inc.

Hector-Neri Castaneda, professor, department of philosophy, Indiana University

Aryeh Kosman, professor, department of philosophy, Haverford College

Joseph Margolis, professor, department of philosophy, Temple University

Physics

Edward G. Uhl, '41, chairman and chief executive officer, Fairchild Industries, Inc.

Robert A. Gross, dean, School of Engineering and Applied Science, Columbia University

Walter D. Wales, professor, department of physics, University of Pennsylvania

Michael J. Thompson, executive director, integrated circuit processing division, Bell Telephone Laboratories

R.S. Knox, '53, professor, department of physics and astronomy, University of Rochester

Robert G. Wheeler, '50, chairman, department of applied physics, Yale University

Rennos Zaphiropoulos, '47, president, Versatec, Inc.

Psychology

Milton H. Grannatt, Jr. '39, president, Fell and Moon Co.

Ernest J. Keen, professor, department of psychology, Bucknell University

Wilbert J. McKeachie, professor, department of psychology, University of Michigan

Eliot Stellar, professor, Institute of Neurological Sciences, University of Pennsylvania Medical School

Religion Studies

Samuel W. Croll, Jr., '48, retired

Jill Raitt, president, American Academy of Religion; professor, department of religion studies, University of Missouri

Robert L. Wilken, professor, department of theology, University of Notre Dame

Charles H. Long, William Rand Kenan, Jr., professor, department of religion, University of North Carolina

Charles H. Reynolds, head, department of religion studies, University of Tennessee

Social Relations

Oldrich Foucek, III, '72, Butz, Hudders and Tallman

John M. Darley, professor, department of psychology, Princeton University

Burkart Holzner, director, University Center for International Studies, University of Pittsburgh

A. Thomas Kirsch, professor, department of anthropology, Cornell University

Center for Social Research

Stanley M. Richman, '55, vice president, Lightning Electric Co.

James S. Cameron, director, Bureau of Child Protective Services, New York State Department of Social Services

Donald Haider, professor, Kellogg Graduate School of Management, Northwestern University

Stewart Wolf, vice president for medical affairs, St. Luke's Hospital, Bethlehem

Division of Speech and Theater

Irvin Feld, '76 (Hon.), president, Ringling Brothers Barnum and Bailey Combined Shows, Inc.

Lucille Bunin Askin, art lecturer

Arnold I. Bramow, '71, vice president for special projects, Ringling Brothers Barnum and Bailey Combined Shows, Inc.

Student Life

Milton H. Grannatt, Jr., '39, president, Fell and Moon Co.

Lynn R. Novick, '78, college relations administrator, Air Products and Chemicals, Inc.

Mr. and Mrs. John Connolly

Ernest H. Ern, '59, vice president for student affairs, University of Virginia

Center for Surface and Coatings Research

Elwood B. Backensto, '43, retired

Charles H. Arrington, general director of research, photo products department, E.I. du Pont de Nemours and Co.

Jerome Kruger, group leader, corrosion and electrodeposition section, National Bureau of Standards

Ulrich Merten, vice president, Gulf Research and Development Center

Roger S. Porter, department of polymer science and engineering, University of Massachusetts

Members of the Administration

Complete degree information for all university administrators may be found in the alphabetical listing of faculty and staff, which follows in this section. Only the highest degrees received are given here.

Offices of the President and Provost

Peter Likins, Ph.D., president
Arthur E. Humphrey, Ph.D., provost and vice president
Paul J. Franz, Jr., LL.D., vice president for development
Joseph F. Libsch, Sc.D., vice president for research (On leave, academic year 1982-83)
Eric V. Ottervik, Ph.D., vice president for administration and planning
John W. Woltjen, B.S., vice president and treasurer
Austin Gavin, LL.B., executive consultant
Nan Van Gieson, Ed.D., assistant provost
Joseph I. Goldstein, Sc.D., assistant vice president for research.
Peter G. Beidler, Ph.D., provost's delegate for student affairs
Linda T. Seeloff, M.Ed., assistant to the president
Michael G. Bolton, M.B.A., executive director of the North East Tier Ben Franklin Consortium and Technology Center, and assistant to the president
Mary I. Malone, B.A., executive secretary to the president

Academic Offices

Donald M. Bolle, Ph.D., dean of the College of Engineering and Physical Sciences
Richard W. Barsness, Ph.D., dean of the College of Business and Economics
John W. Hunt, Ph.D., dean of the College of Arts and Science
Jerry P. King, Ph.D., dean of the Graduate School
Paul VanR. Miller, Ph.D., dean pro tempore of the School of Education
Perry A. Zirkel, Ph.D.; J.D., dean of the School of Education (On leave, 1982-83)
Bobb Carson, Ph.D., associate dean, College of Arts and Science (effective August 15, 1983)
Curtis W. Clump, Ph.D., associate dean, College of Engineering and Physical Sciences
G. Mark Ellis, Ph.D., associate dean, College of Arts and Science
Robert H. Mills, Ph.D., associate dean, College of Business and Economics
William E. Ohnesorge, Ph.D., associate dean, College of Engineering and Physical Sciences
Joseph P. Klein, M.B.A., assistant dean, College of Business and Economics

David Curtis Amidon, Jr., M.A., secretary of the faculty

Office of Admission

Samuel H. Missimer, B.A., director
James W. McGeady, B.A., associate director
Patricia Orban, M.B.A., admission counselor
Vicky P. Sanders, B.S., admission counselor
Linda L. Taylor, B.A., admission counselor
Susan E. Davis, B.A., admission counselor

Office of the Bursar

Joseph Petronio, B.S., bursar
Philip Clauser, B.S., assistant bursar
Dolores Knauss, administrative assistant

Office of the Dean of Students

William L. Quay, Ph.D., dean of students
Robert D. Cohen, Ed.D., associate dean of students
Warren G. Soare, Ed.D., associate dean for residence
Roger Watkins, M.A., assistant dean of students
Muriel Whitcomb, M.A., assistant dean of students
Larry Philippi, B.A., assistant to the dean of students

Office of the Registrar

James H. Wagner, M.A., registrar
Claire G. Biser, associate registrar
Frederick E. Ressler, B.A., associate registrar
Rodney E. Ressler, associate registrar
Edwin C. Eigenbrot, Jr., M.Ed., assistant registrar
Jeanne E. Phifer, assistant to the registrar

Office of Undergraduate Financial Aid

William E. Stanford, B.A., director
Margaret East, assistant director, data processing
Kathryn Fair, counselor
Mary Anne Leavitt, administrative assistant

Offices and Resources

Administrative Systems Office

Paul W. Sire, M.B.A., M.A., director
Wayne Hoffman, senior systems analyst
Roy A. Gruver, M.A., senior systems analyst
Thomas F. Lee, B.A., in Ed., senior systems analys
James C. Baker, A.A., programmer
Gerald A. Lennon, programmer
Heidi L. Seitz, B.A., programmer
Ronald Wagner, A.A., programmer

Control Group

Gail A. Fullman, B.A., manager

Alumni Association

James W. Niemeyer, B.S., executive director
Harry B. Ramsey, B.A., associate executive director
Dennis R. Diehl, M.B.A., assistant executive director
Barbara A. Turanchik, B.A., assistant executive director
Sarah F. Pappas, B.A., assistant to the executive director

Auxiliary Services

Richard S. Metz, M.A.S., director
Richard H. Fritz, B.A., director of events, Stabler Athletic and Convocation Center
Joseph R. Kress, events coordinator, Stabler Athletic and Convocation Center
Michael E. Podd, M.Ed., assistant director of events/conferences and promotions, Stabler Athletic and Convocation Center

Bookstore

Robert W. Bell, M.S., director
Edward L. Fehr, manager
Stephen J. Guttman, B.A., assistant manager

Career Planning and Placement Services

Eugene R. Seeloff, Ed.D., director
Marilyn Mackes, B.A., assistant director
Larry S. Sechney, M.Ed., assistant director

Central Copying and Mailing Service

Catherine Franklin, director
James C. Wiltraut, postmaster, university post office

Chaplaincy Services

The Rev. Hubert L. Flesher, M.A., university chaplain
The Rev. Richard A. Schware, M.Div., Roman Catholic chaplain

Office of Community Relations

James W. Harper, M.S., director
Barbara J. Tallarico, administrative assistant

Computing Center

J. Gary Lutz, Ed.D., director
Joseph P. Holzer, administrative assistant

Office of Continuing Education

James A. Brown, Ph.D., director

Office of the Controller

Timothy J. Hill, M.B.A., controller
F. Robert Huth, Jr., C.P.A., assistant controller
Robert J. Eichenlaub, M.B.A., manager of accounting operations
Larry M. Miley, B.S., manager of research accounting
R. Bruce Brownell, B.S., research accountant
Janet Stumpf, B.A., accounting supervisor

University Counseling Service

Andrew J. Edmiston, Ph.D., director
Robert R. Panos, Ph.D., assistant director
William J. Sibley, M.Ed., counseling psychologist
Patricia A. Finady, B.A., administrative assistant

Office of Development

Paul J. Franz, Jr., LL.D. (Hon.), vice president for development
Robert M. Holcombe, M.B.A., assistant vice president for development
Michael G. Bolton, M.B.A., executive director, North East Tier Ben Franklin Consortium and Technology Center
John T. Fulton, M.S., director of development
Patricia G. Boig, B.A., director of annual giving
Christine D. Smith, M.S., director of corporate and foundation resources
Ferdinand Thun, M.B.A., director for planned giving
Lisa J. Dippre, B.S., assistant director of development
Carl F. Henzelman, III, B.S., assistant director of development
Ralph W. Hunsicker, B.A., manager of development services

Exhibitions and Collection - Art Galleries

Ricardo Viera, B.F.A., director
Judith Goldworm, administrative assistant
Gerald Bastoni, B.A., preparator

Facilities Services

Anthony L. Corallo, M.Arch., director of facilities services and physical planning
Donald J. Knowles, B.A., business manager
Paul T. Miller, director of physical plant
Michael Butryn, A.S., assistant director of physical plant
Donald J. Bergeron, assistant director of physical plant
John Reigel, B.S., assistant to the director of physical plant
Kenneth Yeisley, assistant director of physical plant
Patricia A. Chase, B.A., in Arch., associate director of physical planning
John R. Flynn, B.S., assistant to the director of physical planning
Robert F. Shoup, planning assistant

Forum Office

J. Donald Ryan, Ph.D., co-chairperson (1982-83)
John A. Tarduno, co-chairperson (1982-83)
Lynne Anne Miller, secretary-treasurer (1982-83)
Beatrice Brown, administrative secretary

Fraternity Management Association

Richard M. Jones, B.S., director

Health Services

Carl R. Ruch, M.D., director
Duane E. Stackhouse, M.D., associate director
Robert E. Lentz, M.D., associate director
Lucille H. Pleiss, R.N., administrative assistant
Doris Transue, R.N., nurse
Kathleen J. B. Januszewski, R.N., nurse
Adrienne Hughes, R.P.T., physical therapist

Office of Institutional Purchasing

Ray T. Jensen, B.S., director of institutional purchasing
Harry C. Scarpa, B.S., senior buyer
Joseph S. Nunzio, manager, stores operations
Jeffrey D. Schmoyer, manager of Central Stores
Susan M. Provini, purchasing assistant

Department of Intercollegiate Athletics and Recreation

William B. Leckonby, B.S., director
N. Craig Anderson, M.S., assistant director
Judith T. Baxter, B.S., assistant director
John N. Covert, B.S., assistant director

International Programs

Kathleen Putnam Dean, M.Ed., coordinator for international students and visitors

The Learning Center

Carol Pulham, M.S., director

University Libraries

Berry G. Richards, M.L.S., director of libraries
Mary E. Riley, M.S. in L.S., head, public services, Linderman Library
Christine M. Roysdon, M.S.L.S., M.A. in anthropology, head, Linderman reference
Roseann Bowerman, M.L.S., documents/reference librarian
William J. Fincke, Jr., M.L.S., M.A. in history, reference/interlibrary loan librarian, Linderman Library
Georgia E. Raynor, M.S. in L.S., M.A. in English, assistant librarian, cataloging
Catherine R. Flecksteiner, serials cataloger
Violet Luh, M.L.S., social sciences cataloger
Helen P. Mack, M.S.L.S., science cataloger
Judith E. McNally, M.L.S., humanities cataloger
Kenneth J. Veprek, M.S.L.S., technical coordinator - serials
Susan A. Cady, M.P.A., planning and development librarian
Lorraine C. Abel, manager, order department
Olive Stengel, head, circulation service
Lynn K. Milet, M.L.S., M.Ed., director, media services Linderman Library
Elia N. Schooner, M.A., media technician, media services, Linderman Library
Sharon L. Siegler, M.L.S., assistant director for science and engineering, Mart Library
William Jarvis, M.L.S., reference librarian, Mart Library

Personnel Office

Thomas J. Verbonitz, M.B.A., director of administrative and personnel services
David E. Welty, B.A., assistant director
Maria Martinez-Daday, B.A., personnel associate
Deborah E. Bland, B.S., personnel associate

University Police

Eugene Dax, chief

Office of Public Information

Samuel I. Connor, B.A., director
William Armold, B.A., associate director
Joseph H. Whritenour, assistant director
Rita T. Malone, B.A., assistant director

Office of University Publications

George L. Beezer, director
Marvin H. Simmons, M.F.A., associate director
Diane Whritenour Hutchinson, B.S., assistant designer
Joanne C. Anderson, B.A., staff writer and editor

Office of Research

Richard B. Streeter, Ed.D., director
Claire J. Roddy, A.B., assistant director
Mary Jo Hill, M.A., research administrator
John M. Cheezum, B.S., research administrator
Margaret A. Holzer, administrative assistant

Office of the Vice President for Research

Joseph F. Libsch, vice president (On leave, academic year 1982-83)
Joseph L. Goldstein, Sc.D., assistant vice president
Thomas L. Dinsmore, M.S., research administrator
George R. Jenkins, Ph.M., safety coordinator
Matthew J. Reilly, Ph.D., director of research program development
Louis Robinson, Jr., B.E., director, CAP liaison program

Residence Operations

Barbara L. Kreppel, B.A., director
Kurt W. Salsburg, M.P.A., assistant director
Ann M. Fritz, coordinator, graduate and off-campus housing
Joseph P. Sudbay, residence security director/conference coordinator

Office of Summer Sessions

Norman H. Sam, Ed.D., director

Telephone Services

Janet L.F. Smith, B.A., manager

Transportation Services

Christopher J. Christian, B.S., manager

Office of the Treasurer

John W. Woltjen, B.S., vice president and treasurer
Donald W. Schmoyer, B.S., assistant treasurer
Wanda L. Gulley, M.B.A. - C.P.A., assistant treasurer
James A. Tiefenbrunn, M.B.A., director of the budget
Agnes B. Gifford, administrative assistant
Cynthia A. Bicking, data base coordinator

Directors and Staff Of Research Entities

Directors and staff members of the university's research centers and institutes are listed. Complete degree information may be found in the faculty and staff alphabetical listings.

Center for the Application of Mathematics

Gerald F. Smith, Ph.D., director
Philip A. Blythe, Ph.D.
Dominic G. B. Edelen, Ph.D.
Gregory T. McAllister, Jr., Ph.D.
Eric P. Salathe, Ph.D.
Eric E. Varley, Ph.D.
Anastasios Kydoniefs, Ph.D.
Ronald S. Rivlin, Sc.D., adjunct professor
Kenneth N. Sawyers, Ph.D., executive officer
Jacob Y. Kazakia, Ph.D.
Alister K. Macpherson, Ph.D.
David A. Walker, Ph.D.

Biotechnology Research Center

Marvin Charles, Ph.D., director, fermentation processes, enzyme engineering, plant design
Barry S. Bean, Ph.D., microbial behavior and metabolism, genetics
Arthur E. Humphrey, Ph.D., co-director, fermentation processes, enzyme engineering
Robert L. Johnson, Ph.D., waste water treatment
Fikret Kargi, Ph.D.; fermentation processes

Steven S. Krawiec, Ph.D., microbial ecology and evolution, recombinant DNA, nucleic acid behavior
Richard G. Malsberger, Ph.D, virology, immunology
Joseph R. Merkel, Ph.D., microbial biochemistry, marine microbiology
Janice A. Phillips, Ph.D., fermentation processes, enzyme technology
Jeffrey A. Sands, Ph.D., virology, recombinant DNA, biophysics
Keith J. Schray, Ph.D., enzyme mechanisms, clinical chemistry
Paul J. Usinowicz, Ph.D., waste water treatment
Bland S. Montenecourt, Ph.D.

Computing Center

J. Gary Lutz, Ed.D., director
William R. Harris, M.B.A., associate director
Joseph P. Holzer, administrative assistant
Adolin J. Horvath, B.B.A., systems programming manager
Carol D. Rauch, operations manager
James C. Eshleman, systems programmer
Timothy J. Foley, M.S., technical consultant
Alvin E. Hamilton, B.A., user consultant
Brian D. Hearn, senior systems programmer
Sandra L. Johnson, B.S., systems programmer
Dean T. Krause, operations supervisor
Stephen O. Lidie, B.S., senior systems programmer
Wayne S. Mery, B.S., systems programmer
Monica A. Newman, M.S., senior user consultant
Stephen G. Roseman, B.S., lead systems programmer/consultant
Madhumati Vaze, B.B.A., systems programmer
Kevin R. Weiner, B.A., senior user consultant

Center for Economic Education

William T. Alpert, director
Carl R. Beidleman, Ph.D.
Ralph E. Drtina, Ph.D.
John L. Hilley, Ph.D.
Jon T. Innes, Ph.D.
Arthur E. King, Ph.D.
Laurence G. Kantor, Ph.D.
Michael R. Hodges, Ph.D.
Thomas J. Hyclak, Ph.D.
Michael G. Kolchin, D.B.A.

Educational Service Bureau

Charles W. Guditus, Ed.D., clinical supervision
Robert D. Fleischer, Ed.D., personnel administration
Stinson W. Stroup, J.D., school law
Leroy J. Tuscher, Ph.D., educational technology

Emulsion Polymers Institute

Mohamed S. El-Aasser, Ph.D., co-director
John W. Vanderhoff, Ph.D., co-director
Andrew Klein, Ph.D.
Frederick M. Fowkes, Ph.D.
John A. Manson, Ph.D.
Fortunato J. Micale, Ph.D.
Cesar Silebi, Ph.D.

Energy Research Center

Edward K. Levy, Ph.D., director
Betzalel Avitzur, Ph.D.
Osama A. Badr, Ph.D.
Patricia Bradt, Ph.D.
Hugo S. Caram, Ph.D.
John C. Chen, Ph.D.
Terry J. Delph, Ph.D.
Fazil Erdogan, Ph.D.
Frederick M. Fowkes, Ph.D.
Bruce R. Hargreaves, Ph.D.
Martin P. Harmer, Ph.D.
Roy C. Herrenkoh, Ph.D.
K. Elaine Hoagland, Ph.D.
Michael R. Hodges, Ph.D.
Robert L. Johnson, Ph.D.
Stanley H. Johnson, Ph.D.
Alvin S. Kanofsky, Ph.D.
Fikret Kargi, Ph.D.
Gerard P. Lennon, Ph.D.
Daniel Leonov, Ph.D.
Amarendra Mahalanabis, D.Phil.
John R. McNamara, Ph.D.
Bland S. Montenecourt, Ph.D.
Sudhaker Neti, Ph.D.
Alexis Ostapenko, Ph.D.
Jon I. Parker, Ph.D.
Alan W. Pense, Ph.D.
Richard Roberts, Ph.D.
Robert G. Sarubbi, Ph.D.
William E. Schiesser, Ph.D.
Dale R. Simpson, Ph.D.
Bruce M. Smackey, Ph.D.
Fred P. Stein, Ph.D.
Robert D. Stout, Ph.D.
Robert P. Wei, Ph.D.
David B. Williams, Ph.D.
John D. Wood, Ph.D.
Arthur S. Warnock, Ph.D.

Fairchild-Martindale Center for the Study of Private Enterprise

J. Richard Aronson, Ph.D., director
Robert J. Thornton, Ph.D., coordinator
Richard W. Barsness, Ph.D.
Carl R. Beidleman, Ph.D.
Hugh G. Daubek, Ph.D.
John L. Hilley, Ph.D.
Thomas J. Hyclak, Ph.D.
Laurence G. Kantor, Ph.D.
Michael G. Kolchin, D.B.A.
James A. Largay, III, Ph.D.
John R. McNamara, Ph.D.
Kenneth P. Sinclair, Ph.D.
Lamont F. Steedle, Ph.D.

Institute for Fracture and Solid Mechanics

George C. M. Sih, Ph.D., director
Fazil Erdogan, Ph.D.
Ronald J. Hartranft, Ph.D.
John George Michopoulos, Ph.D.
Robert A. Lucas, Ph.D.
Richard Roberts, Ph.D.
Robert G. Sarubbi, Ph.D.
Dean P. Updike, Ph.D.
Robert P. Wei, Ph.D.

Fritz Engineering Laboratory

Lynn S. Beedle, Ph.D., director
Arthur W. Brune, Ph.D., associate
Ronald C. Chaney, Ph.D., associate
J. Hartley Daniels, Ph.D., associate
George C. Driscoll, Ph.D., associate director
John W. Fisher, Ph.D., associate director
Gerard P. Lennon, Ph.D., associate
Hsai-Yang Fang, Ph.D., director, geotechnical engineering division
Robert L. Johnson, Ph.D., director, hydraulics and environmental engineering division
Le-Wu Lu, Ph.D., director, building systems division
Ti Huang, Ph.D., director, structural concrete division
George C. Driscoll, Ph.D., director, structural connections division
Alexis Ostapenko, Ph.D., director, structural stability division
Roger C. Slutter, Ph.D., director, operations division
Celal N. Kostem, Ph.D., chairperson, computer systems group
Peter Mueller, Ph.D., associate
Richard Roberts, Ph.D., associate
Paul J. Usinowicz, Ph.D., associate
David A. VanHorn, Ph.D., associate
Ben T. Yen, Ph.D., associate
Richard N. Weisman, Ph.D., associate

Irwin J. Kugelman, Sc.D.
Robert M. Sorenson, Ph.D.
John L. Wilson, Ph.D.

Lawrence Henry Gipson Institute for Eighteenth-Century Studies

Jan Fergus, Ph.D., co-director
James S. Saeger, Ph.D., co-director
Michael D. Baylor, Ph.D.
Edward J. Gallagher, Ph.D.
John W. Hunt, Ph.D.
E. Anthony James, Ph.D.
Lawrence H. Leder, Ph.D.
D. Alexander Waldenrath, Ph.D.
W. Ross Yates, Ph.D.

Center for Health Sciences

Ned D. Heindel, Ph.D., director
Jack A. Alhadeff, Ph.D.
Barry S. Bean, Ph.D.
Brent W. Benson, Ph.D.
G. Doyle Daves, Jr., Ph.D.
Natalie M. Foster, Ph.D.
Bruce R. Hargreaves, Ph.D.
Steven Krawiec, Ph.D.
Joseph R. Merkel, Ph.D.
Bland S. Montenecourt, Ph.D.
John G. Nyby, Ph.D.
Eric P. Salathe, Ph.D.
Jeffrey A. Sands, Ph.D.
Keith J. Schray, Ph.D.
George C. M. Sih, Ph.D.
Ramamirtham Venkataraman, Ph.D.

Division of Biological Chemistry and Biophysics

Keith J. Schray, Ph.D.; division director; intermediary metabolism; enzyme kinetics; enzyme immunoassay
Paul Adolf, Ph.D., clinical chemistry
Jack Alhadeff, Ph.D., biochemistry of human metabolic diseases
Barry S. Bean, Ph.D., microbial metabolism and genetics
Brent W. Benson, Ph.D., radiation biophysics; structure of nucleic acids
H. Donald Burns, Ph.D., nuclear medicine
Natalie I. Foster, D.A., Ph.D., radiopharmaceutical syntheses
Ned D. Heindel, Ph.D., medicinal chemistry; nuclear medicine; cancer chemotherapy; bioorganic chemistry
Steven S. Krawiec, Ph.D., microbial ecology; DNA encapsulation
Bland S. Montenecourt, Ph.D., microbial biochemistry and genetics
John G. Nyby, Ph.D., behavioral endocrinology
Jeffrey Sands, Ph.D., biophysics of viruses

Division of Bioengineering

Eric P. Salathe, Ph.D., division director; mathematical modeling in circulatory system
Yuji Hazeyama, Ph.D., metabolic regulation of cardiovascular system
George C.M. Sih, Ph.D., material for artificial limbs, prosthetic apparatus

Center for Information and Computer Science

Donald J. Hillman, M.Litt., director, information science
Robert F. Barnes, Ph.D., computational linguistics
Bruce D. Fritchman, Ph.D.
James Gimpel, Ph.D.
Samuel L. Gulden, M.A., computer science
Ned D. Heindel, Ph.D., biomedical information
Andrew J. Kasarda, Ph.D., information systems
Edwin J. Kay, Ph.D., artificial intelligence
Roger N. Nagel, Ph.D.
John J. O'Connor, Ph.D., information retrieval
Gerhard Rayna, Ph.D., artificial intelligence
Herbert Rubenstein, Ph.D., cognitive science

Center for Marine and Environmental Studies

Irwin J. Kugelman, Ph.D., director
Bobb Carson, Ph.D., oceanic sedimentology
Ronald C. Chaney, Ph.D., associate director, marine geotechnical laboratory
Edward B. Evenson, Ph.D., environmental geology
Hsai-Yang Fang, Ph.D.
Vincent G. Guida, Ph.D., director, The Wetlands Institute
Robert L. Johnson, Ph.D., environmental engineering
Joseph R. Merkel, Ph.D., marine biochemistry
Jon I. Parker, Ph.D.
James M. Parks, Ph.D.
Robert L. Sorenson, Ph.D.
Patricia R. Bradt, Ph.D., associate
Douglas R. Frey, Ph.D., associate
K. Elaine Hoagland, Ph.D., associate
Murray Itzkowitz, Ph.D., associate
Gerard P. Lennon, Ph.D., associate
Hayden N. Pritchard, Ph.D., associate
John R. McNamara, Ph.D.
Hayden N. Pritchard, Ph.D., associate
Paul J. Usinowicz, Ph.D., associate
Richard N. Weisman, Ph.D., associate

Materials Research Center

Donald M. Smyth, Ph.D., director
David A. Thomas, Sc.D., associate director, and director, materials liaison program
Sidney R. Butler, Ph.D., director, electronic materials laboratory
Frank J. Feigl, Ph.D., electronic materials laboratory
Joseph I. Goldstein, Sc.D., electron optical laboratory
Martin P. Harmer, Ph.D., ceramic research laboratory
Richard W. Hertzberg, Ph.D., director, mechanical behavior laboratory
Joseph F. Libsch, Sc.D.
John A. Manson, Ph.D., director polymer laboratory
Michael R. Notis, Ph.D., director, ceramic research laboratory
Richard Roberts, Ph.D., mechanical behavior laboratory
Bruce R. Somers, Ph.D., research engineer
Leslie H. Sperling, Ph.D., polymer laboratory
David B. Williams, Ph.D., director, electron optical laboratory

Institute for Metal Forming

Betzalel Avitzur, Ph.D., director
Ye T. Chou, Ph.D.

National Printing Ink Research Institute

John W. Vanderhoff, Ph.D., director
Eugene M. Allen, Ph.D.
Fortunato J. Micale, Ph.D.
Mohamed S. El-Aasser, Ph.D.

Rauch Center for Executive Development

Richard W. Barsness, Ph.D., director
Benjamin Litt, Ph.D.
Barbara H. Jensen-Osinski, M.A.
Michael G. Kolchin, D.B.A.
June West, M.Ed.

Institute for Research and Development in Education

Raymond Bell, Ed.D., director

Institute for Robotics

Roger N. Nagel, Ph.D., director
Mikell P. Groover, Ph.D.
Emory W. Zimmers, Ph.D.
Forbes T. Brown, Sc.D.

John B. Ochs, Ph.D.
Stanley H. Johnson, Ph.D.
Richard Roberts, Ph.D.
Mark S. Lang, Ph.D.
Herbert Rubenstein, Ph.D.
Samuel L. Gulden, M.A.
Andrew J. Kasarda, Ph.D.
Bruce D. Fritchman, Ph.D.
Marvin H. White, Ph.D.
Louis J. Plebani, Ph.D.
Donald J. Hillman, M.Litt.
Arthur I. Larky, Ph.D.

Sherman Fairchild Laboratory for Solid-State Studies

Wesley R. Smith, Ph.D., coordinator
Sidney R. Butler, Ph.D.
Walter E. Dahlke, Ph.D.
Richard D. Decker, Ph.D.
Gary G. DeLeo, Ph.D.
Frank J. Feigl, Ph.D.
W. Beall Fowler, Ph.D.
Ralph J. Jaccodine, Ph.D.
Karl L. Norian, Ph.D.
Donald M. Smyth, Ph.D.
Wesley J. Van Sciver, Ph.D.
Marvin H. White, Ph.D.
George D. Watkins, Ph.D., Sherman Fairchild Professor of Solid-State Studies

Small Business Center

John W. Bonge, Ph.D., director
John E. Stevens, Ph.D., associate director

Center for Social Research

Roy C. Herrenkohl, Ph.D., director; director, behavioral research and program evaluation
R. Allen Moran, Ph.D.
Arthur E. King, Ph.D., director, urban technology
Thomas O. Blank, Ph.D., associate
Patricia T. Bradt, Ph.D.
Ralph E. Drtina, Ph.D.
John B. Gatewood, Ph.D.
Thomas J. Hyclak, Ph.D.
Robert J. Thornton, Ph.D., associate
Donald T. Campbell, Ph.D.
Maureen A. Callanan, Ph.D.
Judith N. Lasker, Ph.D.
John R. McNamara, Ph.D., associate
Diane T. Hyland, Ph.D.
Vincent G. Munley, Ph.D.
Laura K. Olson, Ph.D.
Alice D. Rinehart, Ed.D.
Herbert Rubenstein, Ph.D.
Eli Schwartz, Ph.D., associate
Lamont F. Steedle, Ph.D.
Stuart K. Webster, Ph.D.
Robert C. Williamson, Ph.D., associate
Robert E. Rosenwein, Ph.D.
Lawrence A. Fehr, Ph.D.

research scientists:
Brenda P. Egolf, M.A.
Ellen C. Herrenkohl, Ph.D.

Center for Surface and Coatings Research

Henry Leidheiser, Jr., Ph.D., director
John W. Vanderhoff, Ph.D., associate director, coatings
Kamil Klier, Ph.D., associate director surfaces
Eugene M. Allen, Ph.D., professor of chemistry and director, color laboratory
Mohamed S. El-Aasser, Ph.D., associate professor of chemical engineering, co-director, Emulsion Polymers Institute
Frederick M. Fowkes, Ph.D., professor emeritus of chemistry
Kamil Klier, Ph.D., professor of chemistry and director, catalysis laboratory
Henry Leidheiser, Jr., Ph.D., professor of chemistry and director, corrosion laboratory
Fortunato J. Micale, Ph.D., associate professor of chemistry and director, colloid laboratory
Cesar Silebi, Ph.D., assistant professor of chemical engineering, Emulsion Polymers Institute
Gary W. Simmons, Ph.D., professor of chemistry and director, surface analysis laboratory
John W. Vanderhoff, Ph.D., professor of chemistry; director, National Printing Ink Research Institute; co-director, Emulsion Polymers Institute
Robert P. Wei, Ph.D., professor of mechanical engineering and mechanics and director, environment-sensitive fracture laboratory
Albert C. Zettlemoyer, Ph.D., Distinguished Professor Emeritus of Chemistry

Institute of Thermo-Fluid Engineering and Science

John C. Chen, Ph.D., director
Douglas F. Abbott, Ph.D.
Osama A.. Badr, Ph.D.
Philip A. Blythe, Ph.D.
Forbes T. Brown, Ph.D.
Hugo Caram, Ph.D.
Curtis W. Clump, Ph.D.
Raymond J. Emrich, Ph.D.
Edward K. Levy, Ph.D.
William L. Luyben, Ph.D.
Alister K. Macpherson, Ph.D.
Sudhakar Neti, Ph.D.
Jerzy A. Owczarek, Ph.D.
Donald O. Rockwell, Ph.D.
Robert G. Sarubbi, Ph.D.
William E. Schiesser, Ph.D.
Cesar A. Silebi, Ph.D.
Charles R. Smith, Ph.D.
Wesley R. Smith, Ph.D.
Frank P. Stein, Ph.D.
Kyra Stephanoff, Ph.D.
Ramamirtham Venkataraman, Ph.D.

Wetlands Institute, The

Vincent G. Guida, Ph.D., director; physiology of oceanic and estuarine animals, ecology of symbiosis and parasitism
Barry S. Bean, Ph.D., microbial genetics and behavior
Bobb Carson, Ph.D., geological oceanography
Bruce R. Hargreaves, Ph.D., environmental physiology
K. Elaine Hoagland, Ph.D., marine ecology and reproductive strategies
Murray Itzkowitz, Ph.D., behavioral ecology of fishes and shore birds
Robert L. Johnson, Ph.D., tertiary sewage treatment
Joseph R. Merkel, Ph.D., biochemistry, of marine bacterial enzymes
James M. Parks, Ph.D., beach preservation
Hayden N. Pritchard, Ph.D., marine botany
Richard N. Weisman, Ph.D.

Faculty and Staff

The first date after the name is the date of appointment to continuous service on the Lehigh faculty or staff; the second date, when the first fails to do so, indicates the date of appointment to the present professional rank. Where the name of the institution awarding a high-level degree is not given, the institution is the same one that awarded the previous degree listed.

P.E. indicates certification as a professional engineer; C.P.A. indicates certified public accountant. A.P.R. indicates accreditation of Public Relations Society of America.

A

Douglas E. Abbott (1977), professor and chairperson of mechanical engineering and mechanics, B.S.M.E., Stanford, 1956; M.S.M.E., 1957; Ph.D., 1961.

Lorraine C. Abel (1956, 1974), manager of procurement and accounts, university libraries.

Mario J. Acerra (1983), adjunct lecturer of administration and supervision. B.A., Lehigh, 1976; M.A., Temple, 1981.

Adele M. Ackerman (1983), adjunct lecturer of psychology. B.S., Villanova, 1977; M.S., Marywood, 1979; M.S., Lehigh, 1982.

John W. Adams (1965, 1969), associate professor of industrial engineering. B.S., Nebraska, 1952; Ph.D., North Carolina, 1962.

Karen A. Adams (1980), varsity coach for women's athletics. B.S., Temple, 1965.

Nicholas Adams (1978), assistant professor and chairman of art and architecture. A.B., Cornell, 1970; A.M., New York, 1973, Ph.D., 1977.

Jack A. Alhadeff (1982), professor of chemistry. B.A., Chicago, 1965; Ph.D., U. of Oregon Medical School, 1972.

William T. Alpert (1981), assistant professor of economics, and director, Center for Economic Education. B.A., Lehigh, 1971; M.A., Columbia, 1974; Ph.D., 1979.

Carlos J. Alvaré (1968, 1980), professor of architecture. B.Arch., Yale, 1947; M.C.P., Pennsylvania, 1952; M.Arch., Yale, 1973.

David Curtis Amidon, Jr. (1965, 1977), lecturer and director of urban studies, and secretary to the faculty. B.A., Juniata, 1957; M.A., Penn State, 1959.

David J. Anderson (1980), systems programmer, Computing Center. B.A., Northwestern, 1969; M.A., Temple, 1980.

Joanne C. Anderson (1981), staff writer and editor, office of university publications. B.A., Elizabethtown, 1980.

William R. Anderson, Jr. (1981), research spectroscopist, chemistry. B.S., San Jose State, 1959.

Kerry Anderson (1980), art teacher, Centennial School. B.S., Kutztown, 1972.

N. Craig Anderson (1966, 1968), business manager and ticket manager, and assistant director, intercollegiate athletics and recreation. B.S., Lehigh, 1960; M.S., Southern Illinois, 1964.

Rosemarie A. Arbur (1972, 1978), associate professor of English. B.A., Nazareth, 1966; A.M., Illinois, 1967; Ph.D., 1972.

William Armold, Jr. (1982), associate director, office of public information. B.A., Lehigh, 1958.

J. Richard Aronson (1965, 1972), professor of economics and director, Fairchild-Martindale Center for the Study of Private Enterprise. A.B., Clark, 1959; M.A., Stanford, 1961; Ph.D., Clark, 1964.

Edward F. Assmus, Jr.(1966, 1970), professor of mathematics. A.B., Oberlin, 1953; A.M., Harvard, 1955; Ph.D., 1958.

Freddie G. Auschwitz (1978), assistant professor of aerospace studies. B.S., Northeastern State, 1971; M.S., Troy State, 1981. Captain, U.S.A.F.

Betzalel Avitzur (1964, 1968), professor of metallurgy and materials engineering, and director, Institute for Metal Forming. B.Sc. and Dip.Ing., Israel Inst. of Tech., 1949; M.S., Michigan, 1956; Ph.D., 1960.

B

Osama A. Badr (1981), assistant professor of mechanical engineering. B.Sc., Cairo U., 1971; M.Sc., 1973; Ph.D., U. of Calgary (Canada), 1977.

D. Raymond Bainbridge (1972, 1978), assistant professor of accounting. B.S., Rider, 1963; M.S., Lehigh, 1972; Ph.D., 1978. C.P.A., Pennsylvania, 1971.

James C. Baker (1979), programmer, administrative systems, A.A., Northampton County Comm. Col., 1979.

Nicholas W. Balabkins (1957, 1966), professor of economics. Dipl.rer.pol., Gottingen (Germany), 1949; M.A., Rutgers, 1953; Ph.D., 1956.

Saul B. Barber (1956, 1966), professor of biology. B.S., Rhode Island State, 1941; Ph.D., Yale, 1954.

Laurence S. Barkan (1979), adjunct lecturer of art.

Thoburn V. Barker (1953, 1977), professor of speech. B.A., Ohio Wesleyan, 1943; M.A., Columbia, 1951.

Malcolm Barksdale (1981), assistant professor of law. B.S., Johnson C. Smith U., 1976; J.D., Howard, 1979.

Robert F. Barnes, Jr. (1965, 1976), professor of philosophy and professor of computing and information science. B.S., M.I.T., 1957; M.A., Dartmouth, 1959; Ph.D., Berkeley, 1965.

Donald D. Barry, (1963, 1970), professor. A.B., Ohio, 1956; M.A., Syracuse, 1959; Ph.D., 1963.

Richard W. Barsness (1978), dean of the College of Business and Economics and professor of management. B.S., Minnesota, 1957; M.A., 1958; M.A.P.A., 1960; Ph.D., 1963.

Gerald Bastoni (1981), preparator, Lehigh University Art Galleries. B.A., Lehigh, 1971.

Dolores Bauer (1980), publications associate, Fritz Engineering Laboratory. B.A., Douglas, 1976.

Michael G. Baylor (1976, 1982), associate professor of history. B.A., Knox, 1964; M.A., Stanford, 1967; Ph.D., 1971.

Judith T. Baxter (1977, 1980), assistant director of intercollegiate athletics and recreation, women's varsity field hockey and lacrosse coach. B.S., Ursinus, 1977.

Barry S. Bean (1973, 1979), associate professor and chairperson of biology. B.A., Tufts, 1964; Ph.D., Rockefeller, 1970.

Lynn S. Beedle (1947, 1978), University Distinguished Professor of Civil Engineering, and director, Fritz Engineering Laboratory. B.S., Berkeley, 1941; M.S., Lehigh, 1949; Ph.D., 1952.

Ferdinand P. Beer (1947, 1957), University Distinguished Professor, Mechanical Engineering and Mechanics. B.S., Geneva (Switzerland), 1933; M.S., 1935; Ph.D., 1937; M.S., Paris, 1938.

George L. Beezer (1973), director, office of university publications; editor, *Lehigh Alumni Bulletin.*

Carl R. Beidleman (1967, 1976), DuBois Professor of Finance, and head of division of finance. B.S., Lafayette, 1954; M.B.A., Drexel, 1961; Ph.D., Pennsylvania, 1968.

Peter G. Beidler (1963, 1977), Lucy G. Moses Distinguished Professor of English and provost's delegate for student affairs. B.A., Earlham, 1962; M.A., Lehigh, 1965; Ph.D., 1968.

Raymond Bell (1966, 1982), professor and chairman, human development. Director, Institute for Research and Development in Education and university marshal. Teaching Cert., St. John's (England), 1961; M.A., Temple, 1966; Ed.D., Lehigh, 1971. (On leave, 1983-84 academic year).

Robert W. Bell (1969), director, university bookstore. B.S., S.U.N.Y. at Albany, 1952; M.S., 1960.

Russell E. Benner (1962), professor of mechanical engineering. B.M.E., Cornell, 1947; M.S. in M.E., Lehigh, 1951; Ph.D., 1959. P.E., Pennsylvania, 1970.

Brent W. Benson (1972), associate professor of physics. B.A., Knox, 1963; M.S., Penn State, 1965; Ph.D., 1969.

Monford S. Benson (1980), adjunct associate professor of chemical engineering. B.S., Missouri, 1968; M.S., 1970; Ph.D., 1973.

Donald J. Bergeron (1978, 1979), assistant director, physical plant.

Ernest E. Bergmann (1969, 1981), professor of physics. A.B., Columbia, 1964; M.A., Princeton, 1966; Ph.D., 1969.

Jerry T. Bidlack (1973, 1980), associate professor and chairperson of music. B.M., Oberlin, 1953; M.M., Boston U., 1957.

Nancy S. Bidlack (1974), adjunct professor of music. B.M., Manhattan School of Music, 1970; M.M., Temple, 1976.

Claire C. Biser (1970, 1977), associate registrar.

Deborah E. Bland (1981), personnel associate. B.S., Bloomsburg State, 1976.

Thomas O. Blank (1980), assistant professor, social psychology, in social relations. B.A., Concordia, 1968; M.Phil., Columbia, 1975; Ph.D., 1976.

Philip A. Blythe (1968, 1970), professor, Center for the Application of Mathematics. B.S., Manchester (England), 1958; Ph.D., 1961.

Hasan Boduroglu (1980), visiting professor, mechanical engineering and mechanics. B.S., Robert College (Turkey), 1966; M.S., 1967; Ph.D., Denver, 1971.

Patricia G. Boig (1978, 1983), director of annual giving. B.A., Lehigh, 1977.

Donald M. Bolle (1980), professor of electrical engineering and dean of the College of Engineering and Physical Sciences. B.Sc., Durham (England), 1954; Ph.D., Purdue, 1961.

Michael G. Bolton (1971, 1983), executive director of the North East Tier Ben Franklin Consortium and Technology Center, and assistant to the president. B.A., Lehigh, 1966; M.B.A., 1967.

John W. Bonge (1972, 1980), professor of management and director, Small Business Center. B.S., Princeton, 1957; M.B.A., 1959; Ph.D., Northwestern, 1968.

Garold J. Borse (1966, 1977), professor of physics. B.S., Detroit, 1962; M.S., Virginia, 1964; Ph.D., 1966.

Roseann Bowerman (1979), documents/reference librarian, Linderman Library. B.A., Ramapo College, 1976; M.L.S., Rutgers, 1978.

Henderson B. Braddick (1956, 1972), professor of international relations. A.B., Washington, 1942; Ph.D., 1957; J.D., Harvard, 1980.

Patricia T. Bradt (1974, 1982), adjunct associate professor of biology. B.A., Cornell, 1952; M.S., Lehigh, 1970; Ph.D., 1974.

Brian G. Brockway (1963, 1978), Distinguished Professor of Law. B.S., Northwestern, 1957; LL.B., Georgetown, 1961; LL.M., 1963. (On leave, 1982-1983).

Arthur L. Brody (1957, 1971), professor of psychology. B.A., George Washington, 1951; Ph.D., Indiana, 1956.

Addison C. Bross (1967, 1973), associate professor of English. B.A., Davidson, 1959; M.A., Duke, 1960; Ph.D., Louisiana State, 1967.

Diane Browder (1981), assistant professor of education. B.A., Duke, 1975; M.Ed., Virginia, 1976; Ph.D., 1981.

Forbes T. Brown (1970), professor of mechanical engineering. S.B., M.I.T., 1958; S.M., 1958; Mech.E., 1959; Sc.D., 1962.

James A. Brown (1977), director of continuing education. B.A., Knox, 1965; M.A., George Washington, 1967; Ph.D., Virginia, 1972.

Thomas L. Brown (1982), assistant professor of aerospace studies. B.S., Mansfield State, 1970; M.P.A., Golden Gate, 1981. Captain, U.S.A.F.

Robert Bruce Brownell (1980), research accountant. B.S., Bloomsburg State, 1976.

Arthur W. Brune (1952, 1971), professor of civil engineering. B.S., Missouri (Rolla), 1941; M.S., 1946; Ph.D., Penn State, 1952; P.E., Pennsylvania, 1957.

Stephen G. Buell (1973, 1983), associate professor of finance. B.S., Lehigh, 1970; M.A., 1971; Ph.D., 1977.

Sidney R. Butler (1969, 1974), professor of metallurgy and materials engineering. B.S., Maine, 1954; M.S., Penn State, 1956; Ph.D., 1960.

Michael Butryn (1981), assistant director, physical plant. A.S., Penn State, 1967.

James A. Butt (1982), adjunct lecturer of electrical and computer engineering. B.S., Lehigh, 1973; M.S., 1982.

Susan E. Byatt (1983), adjunct lecturer of psychology. B.A., Allentown, 1978; M.S., Lehigh, 1983.

Donald R. Byington (1967, 1970), gift and clothing buyer, university bookstore.

C

Susan Cady (1981), planning and development librarian, university libraries. B.A., Wheaton, 1967; M.L.S., Illinois, 1968; M.P.A., Lehigh, 1981.

Maureen A. Callanan (1982), assistant professor of psychology. A.B., Mount Holyoke, 1978; Ph.D., Stanford, 1982.

Donald T. Campbell (1982), University Professor of Social Relations and Psychology. A.B., Berkeley, 1939; Ph.D., 1947.

Bruce Candlish (1980, 1982), assistant professor of theater. B.A., San Jose State, 1971; M.F.A., Penn State, 1982.

Linda W. Candlish (1980), staff psychologist, Centennial School. B.A., Coll. of Wooster, 1970; M.S., Wright State U., 1975.

Ana Caram (1980), research scientist, Energy Research Center. B.S., U. of Buenos Aires (Argentina), 1972; M.S., Minnesota, 1977.

Hugo S. Caram (1977, 1981), associate professor of chemical engineering. B.S., Buenos Aires (Argentina), 1967; Ph.D., Minnesota, 1977.

Bobb Carson (1971, 1982), professor of geology and associate dean, College of Arts and Science (effective August 15, 1983). B.A., Carleton, 1965; M.S., Washington, 1967; Ph.D., 1971.

Alfred J. Castaldi (1964, 1972), professor of education. B.S., Pennsylvania, 1951; M.S., 1956; Ed.D., 1964.

Brenda J. Cavella (1983), adjunct assistant professor of speech and theater. B.A., Allentown, 1979; M.F.A., Memphis State, 1981.

Ronald C. Chaney (1979), associate professor of civil engineering and associate director, Marine Geotechnical Laboratory. B.S., California State (Long Beach), 1968; M.S., 1970; Ph.D., U.C.L.A., 1978. (On leave, 1982-83).

Marvin Charles (1970, 1981), professor of chemical engineering and director, Biotechnology Research Center. B.S., Brooklyn Polytechnic, 1964; M.S., 1967; Ph.D., 1970.

Ellen Z. Charry (1983), adjunct lecturer of religion studies. B.A., Barnard, 1968; M.A., Temple, 1978.

Patricia A. Chase (1974, 1980), associate director of physical planning. B.A., Lehigh, 1974.

John M. Cheezum, Jr. (1964, 1981), research administrator, Office of Research. A.B., Pennsylvania, 1964.

John C. Chen (1970, 1981), Carl R. Anderson Professor of Chemical Engineering, and director, Institute of Thermo-Fluid Engineering and Science. B.Ch.E., Cooper Union, 1956; M.S., Carnegie-Mellon, 1959; Ph.D., Michigan, 1961.

Kwan Wai Cheng (1980), research associate in the Materials Research Center. B.S., North Carolina State, 1974; Ph.D., M.I.T., 1979.

Ye T. Chou (1968, 1970), professor of metallurgy and materials engineering. B.S., Chungking, 1945; M.S., Carnegie-Mellon, 1954; Ph.D., 1957.

Mridulia Choudhuri (1980), research associate in chemistry. B.S., U. of Kalyani (India), 1969; M.S., 1971; Ph.D., 1977.

John G. Christenson (1982), associate professor of aerospace studies. B.A., S.U.N.Y. at Buffalo, 1964; M.A., U. of North Carolina, Chapel Hill, 1972; Lieutenant Colonel, U.S.A.F.

Christopher J. Christian (1978), manager, transportation services. B.S., Lehigh, 1978.

Joyce D. Clark (1978, 1980), assistant to the provost for faculty development. B.S., Wagner, 1971; M.A., New Hampshire, 1975; Ph.D., 1978.

Margaret S. Clauser (1961, 1975), assistant to the dean, College of Business and Economics.

Phillip J. Clauser (1976, 1978), assistant bursar. B.S., Lehigh, 1976.

Curtis W. Clump (1955, 1960), professor of chemical engineering, and associate dean of the College of Engineering and Physical Sciences. B.S. Bucknell, 1947; M.S., 1949; Ph.D., Carnegie-Mellon, 1954.

Alvin Cohen (1962, 1970), professor of economics, director of Foreign Careers program. B.A., George Washington, 1953; M.B.A., Columbia, 1955; Ph.D., Florida, 1962.

Jeffrey Cohen (1983), adjunct assistant professor of psychology. B.A., Brandeis, 1976; Ph.D., Rutgers, 1981.

Robert D. Cohen (1979), associate dean of students. A.B., Cornell, 1960; M.A., Pennsylvania, 1962; Ed.D., Columbia, 1971.

Frank T. Colon (1965, 1980), professor of government. A.B., Geneva, 1954; M.A., Pittsburgh, 1960; Ph.D., 1963.

Mary A. Conahan (1982), adjunct assistant professor of human development. B.A., Penn State, 1949; Ed.D., Lehigh, 1971.

George P. Conard, II (1952, 1960), professor of metallurgy and materials engineering. B.S., Brown, 1941; M.S., Stevens Institute, 1948; Sc.D., M.I.T., 1952.

Samuel I. Connor (1961), director of public information. B.A., Lehigh, 1949.

Anthony L. Corallo (1977, 1980), director of facilities services and physical planning. B.A., Pennsylvania, 1972; M.Arch., 1976.

John N. Covert (1967), assistant director of intercollegiate athletics and recreation, varsity cross country and track coach. B.S.Ed., Buffalo State, 1953.

Keith L. Creamer (1981), instructor of military science. Master Sergeant, U.S. Army.

Allen B. Culf (1980), area coordinator, residence halls. B.A., West Chester State, 1975.

David L. Cundall (1975, 1980), associate professor of biology. B.Sc., McGill, 1967; M.S., Arkansas, 1970; Ph.D., 1974.

Stephen H. Cutcliffe (1976, 1982), assistant to the provost for administration; Science, Technology, and Society program. A.B., Bates, 1968; M.A., Lehigh, 1973; Ph.D., 1976.

D

Walter E. Dahlke (1964, 1981), G. Whitney Snyder Professor of Engineering. Ph.D., Berlin, 1936; Ph.D., (habil.), Jena (Germany), 1939.

Steven J. Damico (1982), assistant athletic trainer. B.S., Eastern Kentucky, 1981; M.S., Arizona, 1982.

J. Hartley Daniels (1964, 1976), professor of civil engineering. B.S., Alberta (Canada), 1955; M.S., Illinois (Urbana), 1959; Ph.D., Lehigh, 1967; P.E., Alberta (Canada), 1955; Pennsylvania, 1975.

Hugh G. Daubek (1979, 1980), assistant professor of marketing. B.A., Ripon College, 1960; B.S., 1961; M.S., 1962; M.B.A., 1973; Ph.D., Utah, 1980.

G. Doyle Daves, Jr. (1981), professor and chairperson of chemistry. B.S., Arizona State, 1959; Ph.D., M.I.T., 1964.

Donald M. Davis (1974, 1978), associate professor of mathematics. B.S., M.I.T., 1967; Ph.D., Stanford, 1972.

Susan E. Davis (1982), admission counselor. B.A., Lehigh, 1982.

Eugene Dax (1963, 1974), chief of police.

Kathleen Putnam Dean (1981), coordinator for international students and visitors. B.A., Springfield, 1978; M.Ed., Lehigh, 1981.

Wolfgang S. deBeauclair (1979), adjunct lecturer of Chinese language and culture. Cert. Lang., Brit. Chin. Comm., Shanghai, 1938; B.Sc.Ed., E. Stroudsburg, 1959; M.A., Seton Hall, 1969.

Jack A. DeBellis (1964, 1980), professor of English. A.B., Florida, 1957; A.M., U.C.L.A., 1959; Ph.D., 1964.

D. Richard Decker (1982), professor of electrical and computer engineering. B.S., North Carolina State, 1961; M.S., 1963; Ph.D., Lehigh, 1970.

Therese Decker (1982), assistant professor of German. B.A., Rutgers, 1970; Ph.D., Harvard, 1981.

Mitrajyoti Deka (1982), research associate. B.Sc., Gauhati U. (India), 1969; M.Sc., Delhi U. (India), 1971; Ph.D., V.P.I., 1980.

Gary G. DeLeo (1979, 1982), assistant professor of physics. B.S., Fredonia, 1974; M.S., Connecticut, 1976; Ph.D., 1979.

Terry J. Delph (1979, 1981), associate professor of mechanics. B.A.E., Georgia Inst. of Tech., 1967; M.S., Calif. Inst. of Tech., 1968; Ph.D., Stanford, 1976.

Dennis R. Diehl (1972), assistant executive director, alumni association. B.S., Lehigh, 1970; M.B.A., 1971.

George A. Dinsmore (1955, 1967), associate professor of civil engineering. B.E., Yale, 1946; M.S., Colorado, 1955.

Thomas L. Dinsmore (1965, 1967), administrator for metallurgy and materials engineering and for vice president—research. B.S., Rochester, 1946; M.S., Princeton, 1948.

Lisa Dippre (1982), assistant director of development. B.S., Lehigh, 1982.

Bruce A. Dodson (1978, 1980), assistant professor of mathematics. B.Sc., Oregon, 1972; M.A., S.U.N.Y. at Stony Brook, 1975; Ph.D., 1976.

William Donahue (1981), supervisor, Saucon Valley athletic complex, and assistant track coach. A.B., Colgate, 1959; M.A., 1967.

Robert A. Donia (1977), adjunct lecturer of electrical and computer engineering. B.S., Manhattan, 1966; M.P.E., Rensselaer, 1967; M.B.A., N.Y.U., 1971; P.E., Pennsylvania, 1975.

Michael F. Dorsey (1983), adjunct assistant professor of human development. B.S., U. of Texas at Arlington; M.A., Western Michigan, 1976; Ph.D., 1979.

Victoria E. Dow (1982), science reference librarian, Mart Library. B.A., Allentown, 1981; M.L.S., Pittsburgh, 1982.

Harry A. Dower (1970), adjunct professor of law. B.A., Lafayette, 1940; J.D., Yale, 1948.

Joseph A. Dowling (1958, 1967), Distinguished Professor of History. A.B., Lincoln Memorial, 1948; M.A., N.Y.U., 1951; Ph.D., 1958.

Alvin E. Doyle (1980), teacher intern, Centennial School. B.S., East Stroudsburg State, 1979.

George C. Driscoll, (1950, 1969), professor of civil engineering, and associate director, Fritz Engineering Laboratory. B.S., Rutgers, 1950; M.S., Lehigh, 1952; Ph.D., 1958. P.E., Pennsylvania, 1969.

Ralph E. Drtina (1980), assistant professor of accounting. B.S., Florida State, 1970; M.B.A., 1972; Ph.D., Ohio State, 1980. C.P.A., Florida, 1972.

Ian P.H. Duffy (1975, 1981), associate professor of history. B.A., Oxford (England), 1965; M.A., 1966; D.Phil., 1974.

E

Margaret W. East (1975, 1978), assistant director for data processing, office of financial aid.

Nikolai Eberhardt (1962, 1970), professor of electrical engineering, and chairman of electrical and computer engineering. Dipl. Engr., Munich (Germany), 1957; Ph.D., 1962.

Jo-Ann Eberle (1980), financial aid counselor. B.S., Cameron U., 1978.

Alice L. Eckardt (1972, 1975), adjunct assistant professor of religion studies. B.A., Oberlin, 1944; M.A., Lehigh, 1966.

Dominic G. B. Edelen (1969), professor of mathematics and professor, Center for the Application of Mathematics. B.E.S., Johns Hopkins, 1954; M.S.E., 1956; Ph.D., 1956.

Andrew J. Edmiston (1967), professor of human development, and director, counseling service. A.B., West Virginia, 1951; M.S., Miami, 1953; Ph.D., Penn State, 1960.

Brenda P. Egolf (1975), research scientist, Center for Social Research. B.A., Upsala College, 1961; M.A., Lehigh, 1975.

Robert J. Eichenlaub (1980, 1982), manager of accounting operations. B.S., Penn State, 1973; M.B.S., Auburn, 1977.

Edwin C. Eigenbrot, Jr. (1979), assistant registrar. B.S., Springfield, 1969; M.Ed., 1970.

Bennett Eisenberg (1972, 1976), associate professor of mathematics. A.B., Dartmouth, 1964; Ph.D., M.I.T., 1968.

Mohamed S. El-Aasser (1972, 1982), professor of chemical engineering and co-director, Emulsion Polymers Institute. B.S., Alexandria (Egypt), 1962; M.S., 1966; Ph.D., McGill, 1972.

G. Mark Ellis (1967, 1978), associate dean of the College of Arts and Science, and professor in the College of Arts and Science. A.B., Yale, 1943; A.M., Harvard, 1947; Ph.D., 1952.

John H. Ellis (1971, 1979), professor of history. B.S., Memphis State, 1955; M.A., 1957; Ph.D., Tulane, 1962.

Raymond J. Emrich (1946, 1955), professor of physics and mace bearer. A.B., Princeton, 1938; Ph.D., 1946.

Fazil Erdogan (1952, 1963), professor of mechanics. Yuk. Muh., Tech. Inst. of Istanbul (Turkey), 1948; Ph.D., Lehigh, 1955.

James C. Erskine (1982), visiting lecturer of philosophy. A.B., Berkeley, 1973; M.A., Princeton, 1980.

James C. Eshleman (1982), operating systems programmer, Computing Center.

Ronald J. Esteve (1981), adjunct assistant professor of human development. B.A., Fairleigh Dickinson, 1972; M.A., S.U.N.Y. at Buffalo, 1977; Ph.D., 1980.

Edward B. Evenson (1973, 1979), associate professor of geology. B.S., Wisconsin, 1965; M.S., 1970; Ph.D., Michigan, 1972.

F

Dale F. Falcinelli (1978), adjunct lecturer in finance, B.S., Lehigh, 1970; M.S., 1972.

Kathryn A. Fair (1968), counselor, office of financial aid.

Peter R. Fallon (1980), visiting assistant professor of economics. B.Sc., The Polytechnic (London), 1969; M.Sc., School of Oriental and African Studies (London), 1970; Ph.D., School of Economics (London), 1974.

Hsai-Yang Fang (1966, 1976), professor of civil engineering. B.S., Hangchow, 1947; M.S., Purdue, 1956; Ph.D., West Virginia, 1966.

Julia S. Fang (1970), adjunct lecturer of Chinese. B.A., Siena Heights Coll., Michigan, 1957; M.Ed., Loyola, 1965.

Douglas D. Feaver (1956, 1966), professor of classics. B.S., Toronto, 1948; M.A., Johns Hopkins, 1949; Ph.D., 1951.

Lesleigh G. Federinic (1973, 1978), administrative assistant, Fritz Engineering Laboratory.

Edward L. Fehr (1967, 1978), manager, university bookstore.

Lawrence A. Fehr (1979), assistant professor of psychology. B.A., Monmouth, 1972; M.A., Fairleigh Dickinson, 1974; Ph.D., Cincinnati, 1977.

Sue Ann Fehr (1966, 1976), supply buyer, university bookstore.

Frank J. Feigl (1967, 1976), professor of physics and electrical and computer engineering; senior staff member, Materials Research Center. A.B., Notre Dame, 1958; Ph.D., Pittsburgh, 1965.

Paul D. Felder (1979), assistant professor of architecture. B.Sc., 1966, R.P.I.; B.Arch., R.P.I., 1966; M.Sc., Penn State, 1969.

Jan Fergus (1976, 1982), associate professor of English, and coordinator, Lawrence Henry Gipson Institute for Eighteenth-Century Studies. B.A., Stanford, 1964; Ph.D., C.U.N.Y., 1975.

Jacqueline M. Fetsko (1949, 1966), assistant research director, National Printing Ink Research Institute, and administrative assistant, Center for Surface and Coatings Research. B.A., Pennsylvania, 1946; M.S., Lehigh, 1953.

Barry J. Fetterman (1968), assistant football coach. B.S., Delaware, 1962.

Karen Fiedler (1980), teacher, Centennial School. B.A., Hood, 1976.

Elizabeth N. Fifer (1973, 1979), associate professor of English. B.A., Michigan, 1965; M.A., 1966; Ph.D., 1969.

Patricia A. Finady (1971), administrative assistant, counseling service. B.A., Moravian, 1965.

William J. Fincke, Jr. (1972), reference/interlibrary loan librarian, Linderman Library. B.A., New York at Oneonta, 1970; M.L.S., New York at Albany, 1971; M.A., Lehigh, 1979.

Michael J. Fiorito, (1982), assistant professor of military science. B.S., Loyola, 1969; M.A., Assumption, 1977. Major, U.S. Army.

John W. Fisher (1961, 1969), professor of civil engineering, and associate director, Fritz Engineering Laboratory. B.S., Washington (St. Louis), 1956; M.S., Lehigh, 1958; Ph.D., 1964. P.E., Illinois, 1960.

Silvio Fittipaldi (1983), adjunct assistant professor of religion studies. A.B., Villanova, 1960; M.A., Augustinian, 1964; Ph.D., Temple, 1976.

Catherine L. Fleckstein (1945, 1965), serials cataloger, university libraries.

Robert Fleischer (1977), assistant professor of education. B.A., Pittsburgh, 1947; M.Litt., 1949; Ed.D., 1954.

Hubert L. Flesher (1971, 1975), university chaplain, and professor of religion studies. M.Div., Pomona, 1954; B.S., Yale, 1958; M.A., 1961.

John R. Flynn (1980), assistant to the director, physical planning. B.S., Virginia, 1980.

Timothy J. Foley (1979), educational coordinator, Computing Center. B.S., Moravian, 1970; M.S., U. of Illinois, 1972.

Robert T. Folk (1961, 1966), professor of physics. B.S. in E.E., Lehigh, 1953; B.S., Phys., 1954; M.S., 1955; Ph.D., 1958.

Natalie Foster (1981), instructor of chemistry. B.S., Muhlenberg, 1971; M.S., Lehigh, 1973; D.A., 1977; Ph.D., 1982.

W. Beall Fowler, Jr. (1966, 1978), professor and chairperson of physics. B.S., Lehigh, 1959; Ph.D., Rochester, 1963.

James R. Frakes (1958, 1974), Edmund W. Fairchild Professor of American Studies. B.A., Penn State, 1948; M.A., Chicago, 1949; Ph.D., Pennsylvania, 1953.

Barbara B. Frankel (1973, 1977), associate professor of anthropology. Ph.B., Chicago, 1947; B.A., Goddard, 1966; M.A., Temple, 1970; M.A., Princeton, 1971; Ph.D., 1974.

Catherine Franklin (1959, 1971), director of central copying and mailing.

Paul J. Franz, Jr. (1944, 1962), vice president for development. B.S., Lehigh, 1944; M.A., 1955; LL.D., (Hon.), 1980.

Robert J. Freund (1980), professor of military science. B.A., Gettysburg, 1964; M.A., Georgetown, 1971; M.S.B.A., Boston U., 1980. Lieutenant Colonel, U.S. Army.

Douglas R. Frey (1978), assistant professor of electrical and computer engineering. B.S., Lehigh, 1973; M.S., 1974; Ph.D., 1977. (On leave, spring, 1983).

Sharon M. Friedman (1974, 1980), associate professor of journalism. B.A., Temple, 1964; M.A., Penn State, 1974.

Bruce D. Fritchman (1969, 1981), professor of electrical and computer engineering. B.S., Lehigh, 1960; E.P., 1961; M.S., 1963; Ph.D., 1967.

Anna M. Fritz (1971), coordinator, graduate and off-campus housing.

Richard H. Fritz (1979), director of events, Stabler Athletic and Convocation Center. B.A., Southern Illinois, 1972.

Susan A. Fritz (1982), teacher intern, Centennial School. B.S., Kutztown State, 1982.

Nancy C. Fulford (1976), health professions coordinator. B.A., Pennsylvania, 1956.

Gail A. Fullman (1972, 1977), manager, control group, administrative systems. B.A., Susquehanna, 1972.

John T. Fulton (1974, 1983), director of development. B.S., Lehigh, 1965; M.A., 1967.

G

Edward J. Gallagher (1969, 1974), associate professor of English. B.S., St. Joseph's, 1964; Ph.D., Notre Dame, 1970.

Anne Galli (1979, 1982), assistant director, Wetlands Institute. B.S., Elmira, 1970; M.S., Rutgers, 1972.

Lucy C. Gans (1981), assistant professor of art. B.F.A., Lake Erie College; M.F.A., Pratt Inst., 1974.

Gerald Garb (1967), professor of economics. B.S., Pennsylvania, 1948; M.A., Berkeley, 1951; Ph.D., 1957.

J. Bruce Gardiner (1972), head swimming coach. B.S., Springfield, 1968; M.Sc., 1972.

Arthur P. Gardner (1958, 1979), professor of German. A.B., Duke, 1944; A.M., Harvard, 1945; Ph.D., 1950.

John B. Gatewood (1978), assistant professor of anthropology. B.A., Illinois, 1971; M.A., 1974; Ph.D., 1978.

Austin Gavin (1974), executive consultant, office of the president. A.B., Ursinus, 1930; LL.B., Pennsylvania, 1933; LL.D. (Hon.), Ursinus, 1974.

Jacob M. Geist (1959, 1979), adjunct professor of chemical engineering. B.S., Purdue, 1940; M.S., Penn State, 1942; Ph.D., Michigan, 1950.

Ann A. Gerber (1959, 1964), administrative assistant to the dean and vice president for student affairs.

Marilyn K. Gerdes (1979), assistant professor of law. A.B., Illinois, 1974; J.D., 1977. (On leave, 1982-83).

Bhaskar K. Ghosh (1961, 1968), professor and chairperson of mathematics. B.Sc., Calcutta (India), 1955; Ph.D., London, 1959.

Agnes B. Gifford (1964, 1975), administrative assistant, treasurer's office.

James F. Gimpel (1982), associate professor of computing and information science. B.S., Drexel, 1961; M.S., Princeton, 1963; Ph.D., 1966.

Norman J. Girardot (1980), associate professor and chairperson, religion studies. B.S., College of the Holy Cross, 1965; M.A., Chicago, 1968; Ph.D., 1974.

Galen C. Godbey (1982), adjunct lecturer of administration and supervision. B.A., (history), Penn State, 1969; B.A. (philosophy), 1969; M.A., 1976.

Steven Louis Goldman (1977), Andrew W. Mellon Distinguished Professor in the Humanities and director, Science, Technology, and Society program, and professor of philosophy. B.S., Polytechnic Inst. of Brooklyn, 1962; MA., Boston, 1966; Ph.D., 1970.

Joseph I. Goldstein (1968, 1979), assistant vice president for research, and Theodore L. Diamond Professor of Metallurgy and Materials Engineering. B.S., M.I.T., 1960; S.M., 1962; Sc.D., 1964.

Judith Goldworm (1976), administrative assistant, Lehigh University Art Galleries.

Maria Amalia B. Good (1982), adjunct lecturer of administration and supervision. B.A., Faculdade Nacional de Filosofia da Universidade Federal do Rio de Janeiro, 1968; M.S., Lehigh, 1982.

Carolyn S. Gordon (1980), assistant professor of mathematics. B.S., Purdue, 1971; M.S., 1972; Ph.D., Washington (St. Louis), 1979.

Carole M. Gorney (1982), assistant professor of journalism. B.A., Albuquerque, 1965; M.S.J., Northwestern, 1966; A.P.R.

Arthur F. Gould (1947, 1953), professor of industrial engineering. S.B., M.I.T., 1938; M.S., Lehigh, 1949; P.E., Pennsylvania, 1949.

Edward T. Grasso (1981, 1982), assistant professor of management. B.S.B.A., Old Dominion University, 1972; M.B.A., 1976; Ph.D., V.P.I., 1982.

David M. Greene (1958, 1964), professor of English. B.A., San Diego State, 1951; M.A., Berkeley, 1952; Ph.D., 1958.

James A. Greenleaf (1970, 1979), associate professor of management, finance and marketing. B.S., Penn State, 1964; M.S., Lehigh, 1966; Ph.D., N.Y.U., 1974.

Mikell P. Groover (1966, 1978), professor of industrial engineering. B.A., Lehigh, 1961; B.S., 1962; M.S., 1966; Ph.D., 1969.

Wayne A. Grube (1980), assistant varsity football coach. B.S., East Stroudsburg, 1960.

Roy Gruver (1979), senior systems analyst. B.A., Lehigh, 1969; M.A., Northern Colorado, 1974.

Charles W. Guditus (1964, 1973), professor of education and chairperson of administration and supervision. B.S., Penn State, 1950; M.S., Bucknell, 1952; Ed.D., Lehigh, 1965.

John B. Guerard, Jr., (1981), assistant professor of finance. A.B., Duke, 1975; M.A., Virginia, 1976; M.S.M., Georgia Inst. Tech., 1977; Ph.D., Texas, 1980.

Vincent J. Guida (1978, 1979), director of The Wetlands Institute. B.S., Rensselaer Polytechnic Inst., 1970; Ph.D., North Carolina State, 1977.

Samuel L. Gulden (1953, 1977), professor of mathematics, and professor of computing and information science. B.S., C.U.N.Y., 1949; M.A., Princeton, 1950.

Wanda L. Gulley (1980), assistant treasurer. B.S., Ohio State, 1973; M.B.A., Lehigh, 1977.

Steven J. Guttman, Jr. (1976, 1977), assistant manager, university bookstore. B.S., Shippensburg State, 1975; M.B.A., Lehigh, 1982.

Teresa E. Gwiazdowski (1980), assistant director of intramurals and recreation. B.S., Temple, 1978; M.S., 1980.

H

Walter C. Hahn, Jr. (1963, 1972), professor of metallurgy and materials engineering. B.S., Lafayette, 1952; M.S., Penn State, 1958; Ph.D., 1960.

John M. Haight, Jr. (1949, 1972), adjunct professor of history. A.B., Princeton, 1940; M.A., Yale, 1947; Ph.D., Northwestern, 1953.

James A. Hall (1979, 1980), assistant professor of accounting. B.S.B.A., Tulsa, 1974; M.B.A., 1975; Ph.D., Oklahoma State, 1979.

Alvin E. Hamilton (1982), user consultant, Computing Center. B.A., Pennsylvania, 1982.

Clark J. Hamman, (1977), Marching '97' director. B.S., Wilkes.

James E. Hansz (1974), associate professor of marketing. A.B., Albion, 1964; M.B.A., Michigan State, 1965; Ph.D., Cincinnati, 1971.

John E. Hare (1974, 1981), associate professor of philosophy. B.A., Oxford, 1971; Ph.D., Princeton, 1975. (On leave, 1982-83).

Bruce R. Hargreaves (1977), assistant professor of biology. B.A., Pomona, 1970; Ph.D., California at Berkeley, 1977.

D. Gary Harlow (1982), assistant professor of mechanical engineering and mechanics. B.A., Western Kentucky, 1973; M.S., Cornell, 1976; Ph.D., 1977.

Martin P. Harmer (1979), assistant professor, metallurgy and materials engineering. B.Sc., Leeds U. (England), 1976; Ph.D., 1979.

James W. Harper (1971), director of community relations. B.S., Northwestern, 1954; M.S., 1956.

William R. Harris (1974, 1978), associate director, Computing Center. B.A., Temple, 1965; M.B.A., 1975.

Robert R. Harson (1966, 1973), associate professor of English. B.A., Wagner, 1963; M.A., Ohio, 1964; Ph.D., 1966.

Ronald J. Hartranft (1966, 1977), professor of mechanics. B.S., Lehigh, 1963; M.S., 1964; Ph.D., 1966.

Albert E. Hartung (1947, 1968), Distinguished Professor of English. B.S., Lehigh, 1947; M.A., 1949; Ph.D., 1957.

Lawrence Hasbrouck (1975, 1980), adjunct professor of aerospace studies. B.A., Colgate, 1953; M.B.A., Ohio State, 1967. Colonel, U.S.A.F.

Helen E. Hawrylo (1967, 1973), manager of payroll.

William C. Hayes, Jr. (1982), child development specialist, Centennial School. B.S., Kutztown, 1982.

Thomas M. Haynes (1952, 1969), professor of philosophy, and director, Freshman Seminars. A.B., Butler, 1941; M.A., Illinois, 1949; Ph.D., 1949.

Yuji Hazeyama (1979), assistant professor of chemistry and research scientist, Center for Health Sciences. B.E., Musashi U. (Japan), 1966; M.E., 1969; Ph.D., Berkeley, 1974.

Brian D. Hearn (1969, 1980), systems programmer, Computing Center.

Ned D. Heindel (1966, 1973), Howard S. Bunn Professor of Chemistry, and director, Center for Health Sciences. B.S., Lebanon Valley, 1959; M.S., Delaware, 1961; Ph.D., 1963.

Carl F. Henzelman, III (1983), assistant director of development. B.S., Lehigh, 1982.

Sidney S. Herman (1962, 1971), professor of biology. B.S., Georgetown, 1953; M.S., Rhode Island, 1958; Ph.D., 1962.

Ellen C. Herrenkohl (1975), research scientist, Center for Social Research. B.A., Pembroke, 1960; M.A. (history), Berkeley, 1961; M.A. (psychology), Boston, 1963; Ph.D., New York, 1969.

Roy C. Herrenkohl (1966, 1975), professor of social psychology and methodology, and director, Center for Social Research. B.A., Washington & Lee, 1954; Ph.D., N.Y.U., 1966.

Richard W. Hertzberg (1964, 1973), New Jersey Zinc Professor of Metallurgy and Materials Engineering. B.S., C.U.N.Y., 1960; M.S., M.I.T., 1961; Ph.D., Lehigh, 1965.

Anna Pirscenok Herz (1966, 1972), professor of Slavic studies. B.S., Pennsylvania, 1949; M.A., 1950; M.A., Columbia, 1951; Ph.D., Pennsylvania, 1956.

Warren R. Heydenberk (1973, 1977), associate professor of human development. B.S., Western Michigan, 1964; M.A., 1965; Ed.D., Northern Colorado, 1971.

Ballard F. Hibbs (1983), assistant professor of military science. B.A., California State - Sacramento. Captain, U.S. Army.

Frank H. Hielscher (1971, 1975), associate professor of electrical and computer engineering. B.S., Drexel, 1961; M.S., Denver, 1963; Ph.D., Illinois, 1966.

Richard P. High (1979), assistant professor of psychology. B.A., Hartford, 1972; M.A., New Hampshire, 1976; Ph.D., 1978.

Brian A. Hill (1974), head basketball coach. B.A., Kennedy, 1969.

Mary Jo Hill (1967), research administrator, Office of Research. B.S., Carnegie-Mellon, 1959; M.A., Pittsburgh, 1964.

Timothy J. Hill (1978), controller. B.A., Kent State, 1966; B.A., Albuquerque, 1971; M.B.A., Georgia State, 1972.

John L. Hilley (1976, 1981), associate professor of economics. B.A., Princeton, 1970; Ph.D., 1978.

Donald J. Hillman (1960, 1964), professor of computing and information science, and director, Center for Information and Computer Science. B.A., Cambridge (England), 1955; M.A., 1959; M.Litt., 1962.

James B. Hobbs (1966, 1979), Frank L. Magee Professor of Business Administration; chairperson of management, finance, and marketing. A.B., Harvard, 1952; M.B.A., Kansas, 1957; D.B.A., Indiana, 1962.

Bruce D. Hockman (1978, 1979), master teacher, Centennial School. B.A., Lafayette, 1971; M.S.Ed., Marywood Coll., 1977.

Michael R. Hodges (1974, 1977), associate professor and chairperson of international relations. B.A., Cambridge (England), 1966; M.A., 1970; Ph.D., Pennsylvania, 1973.

Wayne S. Hoffman (1968), senior systems analyst, administrative systems office.

Mehdi Hojjat (1980), senior research analyst, Small Business Center. B.A., U. of Tehran (Iran), 1975; M.B.A., American, 1978; Ph.D., Lehigh, 1982.

Robert M. Holcombe (1963, 1980), assistant vice president for development. B.S., Lehigh, 1958; M.B.A., 1969.

Joseph P. Holzer (1970), administrative assistant, Computing Center.

Margaret A. Holzer (1966, 1982), administrative assistant, Office of Research.

Carl S. Holzinger (1959, 1979), professor of electrical and computer engineering. B.S., Lehigh, 1956; M.S., 1957; Ph.D., 1963.

Frank S. Hook (1952, 1965), professor and chairperson of English. A.B., Missouri, 1942; M.A., 1947; Ph.D., Yale, 1952.

Raymond L. Horton (1974, 1979), associate professor of marketing. B.S., Maryland, 1966; M.B.A., Indiana, 1968; D.B.A., 1973.

Adolin J. Horvath (1979), systems programming manager, Computing Center. B.B.A., Pennsylvania, 1978.

Chuan-Chih Hsiung (1952, 1960), professor of mathematics. B.S., National Chekiang (China), 1936; Ph.D., Michigan State, 1948.

Ti Huang (1967, 1975), professor of civil engineering. B.S., Tangshan, 1948; M.S., Michigan, 1952; Ph.D., 1960. P.E., New Mexico, 1960.

Wei-Min Huang (1982), assistant professor of mathematics. B.Sc., Tamkang (Taiwan), 1973; M.Sc., 1976; M.A., Rochester, 1980; Ph.D., 1982.

Adrienne M. Hughes (1978), physical therapist, health services. B.S., East Stroudsburg State, 1968; Cert., physical therapy, Columbia, 1973.

Arthur E. Humphrey (1980), provost and vice president and professor of chemical engineering. B.S., U. of Idaho, 1948; M.S., 1950; M.S., M.I.T., 1960; Ph.D., Columbia, 1953.

Ralph W. Hunsicker (1981), manager of development services. B.A., Moravian, 1976.

John W. Hunt (1972, 1973), dean of the College of Arts and Science, and professor of English. B.A., Oklahoma, 1949; B.D., 1952; Ph.D., Chicago, 1961.

Diane Whritenour Hutchinson (1979, 1981), assistant designer, office of university publications. B.S., Kutztown State, 1973.

G. Thomas Hutchinson (1982), assistant wrestling coach. B.S., Lehigh, 1972; M.A., 1979.

F. Robert Huth, Jr. (1979), assistant controller. B.A., Moravian, 1976; C.P.A., 1978.

Thomas J. Hyclak (1979), associate professor of economics. B.A., Cleveland State, 1969; M.A., 1970; Ph.D., Notre Dame, 1976.

Diane T. Hyland (1981), assistant professor of psychology. B.A., Bates, 1974; M.A., Fairfield, 1978; M.A., Syracuse, 1980; Ph.D., 1981.

I

Angelo Iacono (1982), adjunct lecturer of administration and supervision. B.S., East Stroudsburg State, 1952; M.A., Lehigh, 1965.

Jon T. Innes (1965, 1973), associate professor of economics. B.S., Penn State, 1958; M.A., Oregon, 1961; Ph.D., 1967.

Murray Itzkowitz (1979), assistant professor of biology. B.S., Illinois, 1965; M.S., Arizona State, 1967; Ph.D., Maryland, 1970.

George C. Izenour (1982), adjunct professor of theater. A.B., Willenberg Coll., 1934; M.A., 1936; D.F.A. (hon.), 1960; M.A. (hon.), Yale, 1961.

J

Ralph J. Jaccodine (1981), Sherman Fairchild Professor of Solid-State Studies. B.S., U.S. Naval Academy, 1947; M.S., Stevens Inst. of Tech, 1952; Ph.D., Notre Dame, 1958.

Thomas E. Jackson (1937, 1978), adjunct professor of mechanical engineering. B.S., Carnegie-Mellon, 1934; M.S., Lehigh, 1937. P.E., Pennsylvania, 1946.

Stanley J. Jakubowski (1982), adjunct professor of mechanical engineering and mechanics. B.S.M.E., Lehigh, 1957; B.S.E.E., 1958.

Anne J. Jacobson (1982-83), visiting assistant professor of philosophy. A.B., Berkeley, 1965; B.Phil., Oxford, 1967; D.Phil., 1975.

E. Anthony James (1962, 1979), professor of English. A.B., Princeton, 1958; M.A., Pennsylvania, 1960; Ph.D., 1965.

Kathleen J. B. Januszewski (1977), nurse, health services. R.N., St. Luke's Hospital, 1971.

William Jarvis (1982), science reference librarian, Mart Library. B.A., Ohio U., 1967; M.A., Syracuse, 1971; M.L.S., 1979.

Ray T. Jensen (1979), director of institutional purchasing. B.S., Bucknell, 1970.

Barbara Jensen-Osinski (1982), adjunct lecturer, College of Business and Economics. Premier Degre, Sorbonne (Paris), 1969; B.A., Skidmore, 1970; M.A., Lehigh, 1972.

David H. Johnson (1978), assistant professor of mathematics. B.A., Vanderbilt, 1972; Ph.D., 1976.

Jean M. Johnson (1979), reference librarian, Mart Library. B.S., Johns Hopkins, 1969; M.L.S., Rutgers, 1979.

Robert L. Johnson (1970, 1978), professor of civil engineering. B.S., Iowa State, 1957; M.S., 1963; Ph.D., 1969; P.E. Iowa, 1961; Pennsylvania, 1971.

Sandra L. Johnson (1982), systems programmer, Computing Center. B.S., Arizona, 1978.

Stanley H. Johnson (1973, 1980), professor of mechanics. B.S., California, 1962; M.S., 1967; Ph.D., 1973.

Richard M. Jones (1975), director, Fraternity Management Association, B.S., St. Francis, 1968.

Carey B. Joynt (1951, 1960), Monroe J. Rathbone Professor of International Relations. B.A., Western Ontario, 1945; M.A., 1948; Ph.D., Clark, 1951.

K

Arturs Kalnins (1965, 1967), professor of mechanics. B.S., Michigan, 1955; M.S., 1956; Ph.D., 1960.

George E. Kane (1950, 1964), professor and chairperson of industrial engineering. B.S., Penn State, 1948; M.S., Lehigh, 1954. P.E., Pennsylvania, 1955.

Alvin S. Kanofsky (1967, 1976), professor of physics. B.A., Pennsylvania, 1961; M.S., 1962; Ph.D., 1966.

Laurence G. Kantor (1979, 1981), assistant professor of economics, B.S., Rutgers, 1974; M.A., Ohio State, 1976; Ph.D., 1981. (On leave, spring 1983).

Fikret Kargi (1980), assistant professor of chemical engineering. B.S., Hacettepe U. (Turkey), 1972; M.S., 1973; Ph.D., Cornell, 1979.

Andrew J. Kasarda (1968, 1971), associate professor of computing and information science. B.A., Penn State, 1962; M.S., Lehigh, 1966; Ph.D., 1968.

Norimichi Kawashima (1980), research associate, Center for Surface and Coatings Research. B.S., U. of Tokyo, 1971; M.S., 1973; Ph.D., 1977.

Edwin J. Kay (1971, 1977), associate professor of computing and information science and associate professor of psychology. B.A., Rensselaer, 1964; M.S., Lehigh, 1966; Ph.D. (mathematics), 1968; Ph.D. (psychology), 1971.

Jacob Y. Kazakia (1972, 1974), assistant professor, Center for the Application of Mathematics. M.Sc., Istanbul Tech. (Turkey), 1968; Ph.D., Lehigh, 1972.

John D. Keefe (1965, 1975), associate professor of economics. B.S., Lehigh, 1948; M.A., Miami, 1955.

Joseph P. Kender (1968, 1978), professor of human development. A.B., Mt. St. Mary's, 1952; M.A., Villanova, 1955; Ed.D., Pennsylvania, 1967.

Samir A. Khabbaz (1960, 1968), professor of mathematics. B.A., Bethel, 1954; M.A., Kansas, 1956; Ph.D., 1960.

Woo Sik Kim (1980), visiting professor of chemical engineering. B.Ch.E., Yonsei U. (Korea), 1961; M.Ch.E., 1965; Ph.D., 1975.

Yong Wook Kim (1968, 1977), professor of physics. B.S., Seoul National (Korea), 1960; M.S., 1962; Ph.D., Michigan, 1968.

Arthur E. King (1976, 1982), associate professor of economics. A.B., Middlebury, 1971; M.A., Ohio State, 1973; Ph.D., 1976.

Jerry P. King (1962, 1981), dean of the Graduate School and professor of mathematics. B.S., Kentucky, 1958; M.S., 1959; Ph.D., 1962.

Andrew Klein (1979, 1981), professor of chemical engineering. B.S., C.U.N.Y., 1961; M.Sc., Stevens Inst. of Tech., 1965; Ph.D., North Carolina State, 1972.

Joseph P. Klein (1980), assistant dean of the College of Business and Economics. B.S., Penn State, 1950; M.B.A., Lehigh, 1976.

Kamil Klier (1967, 1982), University Professor of Chemistry. Dipl. Chem., Charles (Prague), 1954; C.S.C. (RNDr.), Czechoslovak Academy of Science (Prague), 1961.

Donald J. Knowles (1981), business manager, facilities services. B.A., Allentown College, 1973.

Kenneth P. Kodama (1978), assistant professor of geophysics. B.S., Pennsylvania, 1973; M.S., Stanford, 1977; Ph.D., 1977.

Winfred Kohls (1969), adjunct associate professor of history. B.A., Augustana, 1951; M.A., Berkeley, 1959; Ph.D., 1967.

Michael G. Kolchin (1979, 1980), assistant professor of management. B.A., Miami, 1965; M.B.A., 1970; D.B.A., Indiana, 1980.

David Koran (1982), adjunct assistant professor of chemistry. B.A., Lehigh, 1969; M.S., Northwestern, 1970; Ph.D., U. of Cincinnati, 1976.

Celal N. Kostem (1966, 1978), professor of civil engineering. B.S., Tech. U. of Istanbul (Turkey), 1960; M.S., 1961; Ph.D., Arizona, 1966.

Sharon L. Koury (1982), teacher intern, Centennial School. B.S., Bloomsburg State, 1982.

R. Wayne Kraft (1962, 1965), professor of metallurgy and materials engineering. B.S., Lehigh, 1948; M.S., Michigan, 1956; Ph.D., 1958.

Charles S. Kraihanzel (1962, 1970), professor of chemistry. Sc.B., Brown, 1957; M.S., Wisconsin, 1959; Ph.D., 1962.

Glenn Kranzley (1981), adjunct lecturer of journalism. B.A., Penn State, 1970.

Dean Krause (1975, 1982), operations supervisor, Computing Center.

Steven Krawiec (1970, 1982), professor of biology. A.B., Brown, 1963; Ph.D., Yale, 1968.

Barbara Kreppel (1976, 1979), director, residence operations. B.A., Frostburg State, 1975.

Joseph R. Kress (1971, 1979), operations and events coordinator, Stabler Athletic and Convocation Center.

Andrew N. Kreutzer (1978), instructor of industrial engineering. B.S., Polytechnic Inst. of Brooklyn, 1961; M.A., C.U.N.Y., 1971.

Ronald Krikorian (1982), adjunct lecturer of industrial engineering. B.S., Northern Montana, 1966.

Joanne Krug (1983), adjunct assistant professor of psychology. B.S., Penn State, 1959; M.S., Lehigh, 1962; D.A., 1973.

Irwin J. Kugelman (1981), professor of civil engineering, and director, Center for Marine and Environmental Studies. B.S., Cooper Union, 1958; S.M.S.E., M.I.T., 1960; Sc.D., 1963.

Anastasios Kydoniefs (1969, 1973), associate professor, Center for the Application of Mathematics. B.Sc., Athens (Greece), 1963; M.Sc., Nottingham (England), 1965; Ph.D., 1967.

Jennie Kyler (1982), child development specialist, Centennial School. B.S., Slippery Rock, 1982.

L

Sheila A. LaFrankie (1982), adjunct lecturer of instruction and curriculum. B.Ed., Duquesne, 1962.

Mark S. Lang (1982), assistant professor of mechanical engineering and mechanics. B.S., Texas Tech., 1973; Ph.D., Penn State, 1980.

Donald E. Langlois (1976, 1980), adjunct professor of education. B.S., State College, Mass., 1956; Ed.M., Harvard, 1960; Ed.D., Columbia, 1972.

James A. Largay, III (1980), Arthur Andersen & Co. Alumni Professor of Accounting. B.S.B.A., Denver, 1964; M.B.A., Texas Tech., 1965; M.S., Cornell, 1970; Ph.D., Cornell, 1971. C.P.A., Colorado, 1967.

Arthur I. Larky (1954, 1964), professor of electrical and computer engineering. B.S., Lehigh, 1952; M.S., Princeton, 1953; Ph.D., Stanford, 1957.

Judith N. Lasker (1981), assistant professor of sociology. B.A., Brandeis, 1969; Ph.D., Harvard, 1976.

Bruce A. Laub (1965, 1968), administrative associate, Fritz Engineering Laboratory. B.S., Lehigh, 1961; M.B.A., 1968.

David John Leahigh (1980, 1982), assistant professor of finance. A.B., Georgetown, 1973; M.A., 1975; Ph.D., 1982.

Mary Ann Leavitt (1981), administrative assistant, office of financial aid. B.S., Penn State, 1976.

William B. Leckonby (1946, 1962), director, intercollegiate athletics and recreation. B.S., Lawrence, 1939.

Gary W. Ledebur (1983), adjunct assistant professor of human development. B.A., West Virginia Wesleyan, 1971; M.Ed., Edinboro State, 1972; D.Ed., Lehigh, 1982.

Lawrence H. Leder (1968), professor of history. B.A., Long Island, 1949; M.A., N.Y.U., 1950; Ph.D., 1960.

Thomas F. Lee (1980), senior systems analyst, office of administrative services. B.S., East Stroudsburg, 1966.

Daniel Leenov (1963, 1976), professor of electrical engineering. B.S., George Washington, 1943; M.S., Chicago, 1948; Ph.D., 1951.

Linda S. Lefkowitz (1974, 1979), associate professor of Spanish. B.A., Queens, 1964; M.A., Berkeley, 1968; M.A., Princeton, 1970; Ph.D., 1973.

Henry Leidheiser, Jr. (1968), professor of chemistry, and director, Center for Surface and Coatings Research. B.S., Virginia, 1941; M.S., 1943, Ph.D., 1946.

Robert L. Leight (1963, 1979), chairperson of instruction and curriculum and professor of education. B.S., Kutztown State, 1959; M.A., Lehigh, 1961; M.Ed., 1964; Ed.D., 1966.

Ludwig Lenel (1983), adjunct professor of music. M.A., Oberlin Conservatory of Music, 1940.

Gerald A. Lennon (1979), programmer, administrative systems.

Gerard P. Lennon (1980), assistant professor of civil engineering. B.S., Drexel, 1975; M.S., Cornell, 1977; Ph.D., 1980.

Francis E. Lentz, Jr. (1981), assistant professor human development; staff psychologist, Centennial School. B.A., Wofford, 1969; M.A., Western Carolina, 1976; Ph.D., Tennessee, 1982.

Robert E. Lentz (1973), associate director, health services. A.B., Pennsylvania, 1937; M.D., Temple, 1941.

Edward K. Levy (1967, 1976), professor of mechanical engineering and mechanics and director, Energy Research Center. B.S., Maryland, 1963; S.M., M.I.T., 1964; Sc.D., 1967.

David W.P. Lewis (1977), professor of modern languages and chairperson of modern foreign languages and literature. B.A., Oxford (England), 1953; M.A., 1968; Dipl. European Studies, College of Europe (Bruges), 1958; Dr. De l'Univ., Sorbonne (Paris), 1973.

Joseph F. Libsch (1946, 1969), Alcoa Professor of Metallurgy and Materials Engineering, and vice president for research. B.S., M.S., M.I.T., 1940; Sc.D., 1941; P.E., Pennsylvania, 1947. (On leave, 1982-83).

Stephen O. Lidie (1979), senior systems programmer, Computing Center. B.S., Lehigh, 1977.

Kathleen H. Liebhardt (1982), assistant to the provost. B.A., Marquette Univ., 1961; M.A., Delaware, 1980.

John O. Liebig, Jr. (1946, 1970), professor of civil engineering. B.S., Lehigh, 1940; M.S., 1949. P.E. Pennsylvania, 1951.

H. Charles Liebold (1982), adjunct lecturer of electrical and computer engineering. B.S., Rensselaer, 1972; M.S., Lehigh, 1979.

Peter Likins (1982), president. B.S., Stanford, 1957; S.M., M.I.T., 1958; Ph.D., Stanford, 1965.

J. Ralph Lindgren (1965, 1979), professor and chairperson of philosophy. B.S., Northwestern, 1959; M.A., Marquette, 1961; Ph.D., 1963.

Benjamin Litt (1970, 1983), associate professor of management. B.S., Brooklyn Polytechnic, 1950; M.S., Stevens, 1957; M.B.A., N.Y.U., 1964; Ph.D., 1970.

Larry E. Long (1976, 1980), associate professor of industrial engineering. B.S., Oklahoma, 1967; M.S., 1971; Ph.D., 1974.

Roland W. Lovejoy (1962, 1976), professor of chemistry. B.A., Reed, 1955; Ph.D., Washington State, 1960.

Le-Wu Lu (1957, 1969), professor of civil engineering. B.S., National Taiwan, 1954; M.S. Iowa State, 1956; Ph.D., Lehigh, 1960.

Yong-Zai Lu (1979), research associate in chemical engineering.

Robert A. Lucas (1958, 1969), associate professor of mechanical engineering. B.S., Lehigh, 1957; M.S., 1959; Ph.D., 1964.

Joseph P. Lucia (1982), reference librarian, Linderman Library. B.A., McGill, 1977; M.A., U. of Toronto, 1978; M.L.S., Syracuse, 1982.

Frank S. Luh (1965, 1977), professor of accounting. B.A., National Taiwan (Taiwan), 1957; M.S., Illinois, 1961; Ph.D., Ohio State, 1965.

Violet Luh (1979), social sciences cataloger. B.S., Taiwan, 1960; M.L.S., Michigan, 1965.

J. Gary Lutz (1971, 1981), professor of human development, and director, Computing Center. B.S., Lehigh, 1965; M.A., 1968; Ed.D., 1969.

William L. Luyben (1967, 1973), professor of chemical engineering. B.S., Penn State, 1955; M.B.A., Rutgers, 1958; M.S., 1962; Ph.D., Delaware, 1963.

M

Chi-Ming Ma (1979), research associate in chemical engineering.

Helen P. Mack (1974), science cataloger, university libraries. B.A., Moravian, 1973; M.S.L.S., Drexel, 1974.

Marilyn Mackes (1982), assistant director, career planning and placement services. B.A., Wilfird Laurier (Ontario), 1976.

Alistair K. Macpherson (1971, 1974), professor of mechanical engineering and mechanics. B.S., Sydney (Australia), 1957; M.S., 1965; Ph.D., 1967.

Amarendra K. Mahalanabis (1982), visiting professor of electrical and computer engineering. B.Sc., Calcutta U. (India), 1954; M.Sc., (Technical) Calcutta, 1957; D.Phil., Calcutta U., 1962.

Mary I. Malone (1966), executive secretary to the president. B.A., Rosary, 1945.

Rita T. Malone (1982), assistant director, office of public information. B.A., Pennsylvania, 1979.

Richard G. Malsberger (1959, 1966), professor of biology. B.A., Lehigh, 1948; M.S., 1949; Ph.D., 1958.

John A. Manson (1966, 1971), professor of chemistry, and director of the polymer laboratory, Materials Research Center. B.Sc., McMaster (Ontario), 1949; M.Sc., 1950; Ph.D., 1956.

Maria Martinez-Daday (1978), personnel associate. B.A., Allentown, 1972.

Gregory T. McAllister, Jr. (1965, 1972), professor of mathematics, and professor, Center for the Application of Mathematics. B.S., St., Peter's, 1956; Ph.D., Berkeley, 1962.

George E. McCluskey, Jr. (1965, 1976), professor of astronomy and mathematics. A.B., Pennsylvania, 1960; M.S., 1963; Ph.D., 1965.

James W. McGeady (1950, 1959), associate director of admission. B.A., Lehigh, 1950.

Muffet McGraw (1982), head women's basketball and softball coach. B.S., St. Joseph's, 1977.

James R. McIntosh (1966, 1973), associate professor of sociology and chairperson, department of social relations. B.A., Colby 1960; M.A., New School for Social Research, 1963; Ph.D., Syracuse, 1970.

James A. McLennan, Jr. (1948, 1962), professor of physics. A.B., Harvard, 1948; M.S., Lehigh, 1950; Ph.D., 1952.

Judith E. McNally (1972), humanities cataloger, university libraries. B.A., Central Connecticut State, 1968; M.L.S., S.U.N.Y. at Albany, 1972.

John R. McNamara (1973, 1976), professor of economics, and director, M.B.A. program. B.A., Columbia, 1959; M.S., Rensselaer, 1965; Ph.D., 1971.

Charles R. McNaron (1969, 1975), head athletic trainer. B.S., Mississippi State, 1965.

Norman P. Melchert (1962, 1974), professor of philosophy. B.A., Wartburg, 1955; B.D., Lutheran Theological Seminary, 1958; M.A., Pennsylvania, 1959; Ph.D., 1964.

Salvatore V. Mentesana (1982), assistant men's basketball coach. B.A., Providence College, 1969.

Joseph R. Merkel (1962, 1965), professor of biochemistry, and director, Marine Biochemistry Laboratory, Center for Marine and Environmental Studies. B.S., Moravian, 1948; M.S., Purdue, 1950; Ph.D., Maryland, 1952.

Wayne S. Mery (1980), systems programmer, Computing Center. B.S., Penn State, 1980.

James F. Mesite, Jr. (1982), assistant professor of military science. B.S., West Point, 1969. Major, U.S. Army.

Richard S. Metz (1979), director of auxiliary services. B.S., Ohio State, 1969; M.A.S., Johns Hopkins, 1976.

Fortunato J. Micale (1962, 1970), associate professor of chemistry. B.A., St. Bonaventure, 1956; B.S., Niagara, 1959; M.S., Purdue, 1961; Ph.D., Lehigh, 1965.

Alan Michaels (1981), visiting professor of chemical engineering, Sc.D., M.I.T., 1948.

Joseph Mickley (1982), adjunct lecturer, School of Education. B.S., Colorado State, 1965; M.A., 1966; Ed.D., Lehigh, 1977.

John A. Mierzwa (1966, 1972), professor of education. B.S., Ohio, 1954; M.A., 1955; Ed.M., Harvard, 1958; Ed.D., 1961.

Jeffrey Milet (1976, 1978), associate professor and head, speech and theater; artistic director of Wilbur Drama Workshop. B.S., Bridgeport, 1963; M.F.A., Yale, 1969.

Lynn K. Milet (1978), director of media services, university libraries. B.S., Bridgeport, 1965; M.S., 1971; M.L.S., S.U.N.Y. at Geneseo, 1976.

Larry M. Miley (1967), manager of research accounting, office of the controller. B.S., Penn State, 1961.

Charles L. Miller (1982), adjunct lecturer of administration and supervision. B.S., Bloomsburg State, 1968; M.Ed., Lehigh, 1973; Ed.D., 1981.

Paul T. Miller (1961, 1972), director, physical plant.

Paul VanR. Miller (1966, 1973), dean pro tempore, School of Education, and professor of human development. B.A., Yale, 1946; M.A., Pennsylvania, 1948; Ph.D., 1965.

Robert H. Mills (1964, 1976), professor of accounting, and associate dean, College of Business and Economics. B.S., Colorado, 1949; M.S., 1955; Ph.D., Wisconsin, 1960; C.P.A., Illinois, 1957.

Samuel H. Missimer (1950, 1962), director of admission. B.A., Lehigh, 1950.

Mary Ann Mittnacht (1982), assistant manager, development services. A.S., N.A.C.C., 1982.

Kalyan Mondal (1979), assistant professor of electrical and computer engineering. B.Sc., Calcutta (India), 1969; B.Tech., 1972; M.Tech, 1974; Ph.D., California at Santa Barbara, 1978. (On leave, spring, 1983).

Sutton Monro (1959, 1964), professor of industrial engineering. B.S., M.I.T., 1942.

Bland S. Montenecourt (1981), associate professor of biology. B.A., Rosemont College, 1964; Ph.D., Rutgers, 1968.

Carl L. Moore (1948, 1963), professor of accounting. A.B., Bucknell, 1943; M.A., Pittsburgh, 1948; C.P.A., Pennsylvania, 1952.

R. Allen Moran (1973, 1977), associate professor of economics, B.A., Columbia, 1965; A.M., Chicago, 1967; Ph.D., Massachusetts, 1971.

Edward P. Morgan (1976, 1981), associate professor and chairperson (spring, 1983) of government. B.A., Oberlin, 1968; M.A., Brandeis, 1973; Ph.D., 1975.

Peter Mueller (1980), associate professor of civil engineering. Dipl. Bauing, ETH (Zurich), 1967; Dr. sc. tech., 1978.

Joan T. Mulhern (1979), area coordinator. A.A., Montgomery County Community College, 1973; B.S., West Chester, 1976.

Rosemary J. Mundhenk (1973, 1982), associate professor of English and faculty associate, office of the provost. B.A., U.S.C., 1967; M.A., U.C.L.A., 1969; C. Phil., 1970; Ph.D., 1972.

Vincent G. Munley (1980), assistant professor of economics, B.A., B.S., Lehigh, 1974; M.A., S.U.N.Y., 1977; Ph.D., 1979.

Michael J. Murphy (1982), staff psychologist and partial hospitalization director, Centennial School. B.S., Drexel, 1972; M.S., Penn State, 1981.

Paul B. Myers, Jr. (1962, 1980), professor of geology. A.B., Colgate, 1955; M.S., Lehigh, 1957; Ph.D., 1960.

N

Roger N. Nagel (1982), professor of electrical and computer engineering, and director, Institute for Robotics. B.S., 1964; M.S., Stevens Inst. of Technology, 1969; Ph.D., Maryland, 1976.

Patricia L. Naylor (1979), area coordinator, residence operations. A.B., Lafayette, 1978; M.P.A., Lehigh, 1981.

David M. Nester (1982), child development specialist, Centennial School. B.A., Muhlenberg, 1982.

Sudhakar Neti (1978, 1979), associate professor of mechanical engineering and mechanics. B.E., Osmania (India), 1968; M.S., Kentucky, 1970; Ph.D., 1977.

Monica A. Newman (1975, 1980), educational coordinator, Computing Center. B.S., Indiana U. of Pa., 1971; M.S., Lehigh, 1978.

William Newman (1968, 1979), associate professor and chairperson of psychology. B.S., C.U.N.Y. (Brooklyn), 1964; Ph.D., Stanford, 1968.

James W. Niemeyer (1968, 1970), executive director, alumni association. B.S., Lehigh, 1943.

Karl H. Norian (1982), associate professor of electrical and computer engineering. B.Sc., Queen Mary College (London), 1973; Ph.D., Imperial College of Science and Tech. (London), 1977.

Michael R. Notis (1967, 1979), professor of metallurgy and materials engineering. B.S., Lehigh, 1960; M.S., 1963; Ph.D., 1969.

Debra Hartzell Nyby (1976, 1982), administrative associate, the Graduate School. B.A., Moravian, 1975; M.Ed., Lehigh, 1979.

John G. Nyby (1977, 1980), associate professor of psychology. B.A., U. of Texas (Austin), 1968; Ph.D., 1974.

O

John B. Ochs (1979), associate professor of mechanical engineering and mechanics. B.S., Villanova, 1972; M.S., Penn State, 1975; Ph.D., 1980.

John J. O'Connor (1967, 1973), professor of computing and information science. B.A., Columbia, 1945; M.A., Cornell, 1947; Ph.D., Columbia, 1952.

William E. Ohnesorge (1965, 1982), professor of chemistry and associate dean of the College of Engineering and Physical Sciences. Sc.B., Brown, 1953; Ph.D., M.I.T., 1956.

Jean C. Oi (1982), assistant professor of government. B.A., Indiana, 1971; M.A., Michigan, 1975; Ph.D., 1983.

Laura Katz Olson (1974, 1980), associate professor of government. B.A., C.U.N.Y., 1967; M.A., Colorado, 1971; Ph.D., 1974.

John Ondria (1967, 1970), associate professor of electrical engineering. B.S., Lehigh, 1960; M.S., 1963; Ph.D., 1967. (On leave, spring 1983).

Patricia A. Orban (1980), admission counselor. B.A., East Stroudsburg State, 1977.

Alexis Ostapenko (1957, 1965), professor of civil engineering. Dipl. Ing., Munich Institute of Technology (Germany), 1951; Sc.D., M.I.T., 1957.

Tulza Oszoy (1981, 1982), adjunct assistant professor of mechanical engineering. B.S., Technical Inst. of Istanbul, 1971; M.S., 1971; Ph.D., 1980.

Peggy A. Ota (1971, 1980), associate professor of electrical and computer engineering. B.A., Cornell, 1966; M.S., Pennsylvania, 1969; Ph.D., 1972.

Eric V. Ottervik (1966, 1974), vice president for administration and planning. B.S., Carnegie-Mellon, 1959; M.A., Pittsburgh, 1961; Ph.D., 1966.

Jerzy A. Owczarek (1960, 1965), professor of mechanical engineering. Dipl. Ing., Polish Univ. Col. (London), 1950; Ph.D., London, 1954.

Catherine J. Ozeck (1980), computer specialist, Centennial School. B.S., Penn State, 1978.

Mustafa R. Ozgu (1974), adjunct professor of mechanical engineering and mechanics. B.S.M.E., Middle East Technical Inst. (Turkey), 1967; M.S.; Ph.D., Lehigh, 1971.

P

Artis J. Palmo (1971, 1977), associate professor of human development. B.S., California State (Pa.), 1967; M.A., West Virginia, 1968; Ed.D., 1971.

Robert R. Panos (1964, 1969), assistant director of counseling and testing. B.A., Queen's, 1956; M.S., Penn State, 1958; Ph.D., 1968.

Aigli H. Papantonopoulou (1979), assistant professor of mathematics. B.A., Barnard, 1969; M.A., Berkeley, 1971; Ph.D., 1975.

Sarah F. Pappas, (1981), assistant to the executive director, alumni association. B.A., Lehigh, 1980.

Jon I. Parker (1981), assistant professor of biology. B.S., Bloomsburg, 1965; M.S., Idaho, 1972; Ph.D., New Hampshire, 1974.

David P. Parkin (1981), assistant professor of military science. B.S., Texas A & M, 1969; M.S., 1969; M.S., American Tech. U., 1981. Major, U.S. Army.

Thomas L. Parkinson (1981), associate professor of marketing. A.B., Dartmouth, 1964; M.B.A., Massachusetts, 1965; Ph.D., 1972.

James M. Parks (1967, 1970), professor of geology. A.B., Kansas, 1948; M.S., Wisconsin, 1949; Ph.D., 1951.

Harriet L. Parmet (1976), adjunct lecturer of modern Hebrew. A.B., Temple, 1950; M.Sc.Ed., Temple, 1962; B.Heb. Lit., Gratz Coll., Philadelphia, 1979.

Ruth B. Parr (1967, 1968), teacher, Centennial School and adjunct assistant professor of education. B.S., Simmons, 1945; M.Ed., Lehigh, 1969.

Terry L. Pavlis (1981), assistant professor of geology. B.S., U. of South Dakota, 1974; M.S., U. of Utah, 1979; Ph.D., 1982.

Linda C. Pavlikowski (1982), liaison teacher-counselor, Centennial School. B.S., California State, 1974; M.Ed., Indiana U. of Pennsylvania, 1982.

John W. Paul (1974, 1978), assistant professor of accounting. B.A., Cornell, 1965; M.B.A., Lehigh, 1971; Ph.D., 1978. C.P.A., Florida, 1972.

Philip Pendleton (1979), research associate, Center for Surface and Coatings Research. B.S., U. of Edinburgh, 1975; M.S., U. of Bristol, 1977; Ph.D., 1980.

Steven R. Penman (1975), head ice hockey coach. B.A., Lake Forest, 1975.

Alan W. Pense (1957, 1971), R.D. chairperson and Stout Professor of Metallurgy and Materials Engineering. B.S., Cornell, 1957; M.S., Lehigh, 1959; Ph.D., 1962.

Thomas E. Persing (1978, 1982), adjunct professor of education. B.S., Bloomsburg State, 1955; M.A., Lehigh, 1959; Ed.D., 1975.

Joseph A. Petronio (1967, 1968), bursar. B.S., King's, 1960.

Robert A. Pfenning (1969, 1977), adjunct professor of accounting. B.A., Wesleyan, 1962; M.B.A., Michigan, 1964. C.P.A., New York, 1967.

Jeanne E. Phifer (1974, 1978), assistant to the registrar.

Larry Philippi (1980), assistant to the dean of students. B.A., Bowling Green State, 1978.

Charles Robert Phillips, III (1975, 1980), associate professor and chairperson of classics. B.A., Yale, 1970; B.A., Oxford (England), 1972; M.A., 1979; Ph.D., Brown, 1974.

Janice A. Phillips (1980), assistant professor of chemical engineering. B.S., Villanova, 1973; M.S., 1976; Ph.D., Pennsylvania, 1981.

Beth A. Pianucci (1982), adjunct lecturer of journalism. B.S., Lehigh, 1981.

Warren A. Pillsbury (1962, 1965), associate professor of economics. A.B., New Hampshire, 1953; M.S., Florida State, 1958; Ph.D., Virginia, 1963.

Louis J. Plebani (1974, 1982), associate professor of industrial engineering. B.S., Lehigh, 1968; M.S., American, 1972; Ph.D., Lehigh, 1976.

Lucille H. Pleiss (1961, 1971), administrative assistant to the director, health services. R.N., St. Luke's Hospital, 1949.

Charlene Pletz (1982), computer specialist, Centennial School. B.S., Lock Haven State, 1982.

Michael E. Podd (1979, 1981), assistant director of events/conferences and promotions, Stabler Athletic and Convocation Center. B.A., State U. College at Buffalo, 1974; M.Ed., S.U.N.Y. (Buffalo), 1976.

Michael Pressler (1978, 1979), assistant professor of English. B.A., Massachusetts, 1969; M.A., Connecticut, 1971; Ph.D., 1979.

Ronald D. Prevost (1979), chief instructor of military science. B.A., Campbell U., 1974. Sergeant Major, U.S. Army.

Hayden N. Pritchard (1964, 1970), associate professor of biology. A.B., Princeton, 1955; M.S., Lehigh, 1960; Ph.D., 1963.

Margaret Lynn Pritchard (1982), visiting assistant professor of chemistry. B.Sc. (hon.), Queens U. at Kingston (Ontario), 1975; Ph.D., College of Medicine of Penn State, 1981. (Until July, 1983).

Carol Pulham (1982), adjunct lecturer of English, and acting head, The Learning Center. B.S., Cedar Crest, 1976; M.S., Lehigh, 1978.

Dorothy A. Purdy (1977, 1979), business manager of division of speech and theater.

Q

William L. Quay (1963, 1970), dean of students. A.B., Muhlenberg, 1956; A.M., Pennsylvania, 1957; Ph.D., Lehigh, 1969.

Clifford S. Queen (1972, 1976), associate professor of mathematics. Ph.D., Ohio State, 1969.

R

Shelden H. Radin (1963, 1974), professor of physics. B.S., Worcester Polytechnic, 1958; M.S., Yale, 1959; Ph.D., 1963.

Harry B. Ramsey (1963, 1971), associate executive director, alumni association. B.A., Lehigh, 1950.

V.R. Gopala Rao (1972, 1978), associate professor of mathematics. B.Sc., Andhra (India), 1964; M.S., 1965; A.M., Illinois, 1967; Ph.D., 1972.

Carol D. Rauch (1968, 1980), operations manager, Computing Center.

Henry W. Ray (1975), adjunct professor of education. B.S., Kent State, 1947; M.A., Columbia, 1952; Ed.D., 1956.

Gerhard Rayna (1955, 1969), associate professor of mathematics and acting head, division of computing and information science. A.B., Harvard, 1952; M.A., Princeton, 1953; Ph.D., 1965.

Helen Z. Rayner (1963, 1975), administrative assistant, career planning and placement services.

Georgia E. Raynor (1961, 1974), assistant librarian, cataloging. A.B., Chatham, 1945; M.A., Lehigh, 1954; M.S.L.S., Columbia, 1954.

Richard J. Redd (1958, 1970), professor of art. B.Ed., Toledo, 1953; M.F.A., Iowa, 1958.

James J. Reid (1982), assistant professor of Islamic history and religion. B.A., Berkeley, 1970; M.A., Santa Clara, 1973; Ph.D., U.C.L.A., 1978.

John R. Reigel (1979), assistant to the director, physical plant. B.S.M.E., Penn State, 1950.

Matthew J. Reilly (1982), director, research program development, office of vice president for research. B.S., Carnegie-Mellon, 1962; M.S., U. of Illinois, 1964; Ph.D., 1966.

Frederick E. Ressler (1952, 1964), associate registrar. B.A., Lehigh, 1952.

Rodney E. Ressler (1947, 1977), associate registrar.

Dolores Bauer Rice (1981), publications associate, Fritz Engineering Laboratory. B.A., Rutgers, 1976.

Berry G. Richards (1969), 1976), director of libraries. A.B., Vassar, 1952; M.L.S., New York at Albany, 1969.

Wallace J. Richardson (1952, 1959), professor of industrial engineering. B.S., U.S. Naval Academy, 1941; M.S., Purdue, 1948. P.E., Delaware, 1956.

Amy E. Richlin (1982), assistant professor of classics. B.A., Princeton, 1973; Ph.D., Yale, 1978.

Martin L. Richter (1965, 1972), associate professor of psychology. B.A., Rutgers, 1960; Ph.D., Indiana, 1965.

Robert C. Rickards, assistant professor of government. B.A., Lehigh, 1967; M.A., Penn State, 1970; M.A., Michigan, 1973; Ph.D., 1980.

Mary G. Riley (1953, 1968), head, public services, Linderman Library. B.A., Penn State, 1952; M.S. in L.S., Drexel, 1953.

Shirley E. Riley (1966, 1975), researcher, office of the controller.

Alice D. Rinehart (1964, 1974), associate professor of education, and coordinator of educational placement. B.A., Smith, 1947; M.Ed., Lehigh, 1965; Ed.D., 1969.

Virginia Riofski (1979), teacher, Centennial School. B.A., Bloomsburg, 1979; M.Ed., Lehigh, 1981.

Augustine Ripa, Jr. (1979), assistant professor of theater. B.A., Loyola U. of Chicago, 1974; M.F.A., Northwestern, 1976.

Edith D. Ritter (1980), program administrator, Small Business Center. B.S., U. of British Columbia, 1962; M.B.A., Lehigh, 1980.

Richard Roberts (1964, 1975), professor of mechanical engineering. B.S., Drexel, 1961; M.S., Lehigh, 1962; Ph.D., 1968.

Louis Robinson, Jr. (1974), director, CAP Liaison Program, Computing Center. B.E., Johns Hopkins, 1949.

Donald O. Rockwell, Jr. (1970, 1976), professor of mechanical engineering and mechanics. B.S., Bucknell, 1964; M.S., Lehigh, 1965; Ph.D., 1968.

Claire J. Roddy (1977), assistant director, Office of Research. A.B., Houghton, 1951.

Sarah K. Rogers (1980, 1981), property manager, office of purchasing. B.S., West Virginia Wesleyan, 1975.

Thomas J. Rogish (1982), assistant football coach. B.S., Indiana U., 1973; M.Ed., Frostburg State, 1981.

Stephen G. Roseman (1972), systems programmer, Computing Center. B.S., Lehigh, 1972.

David M. Rosenkrans (1980), physical education teacher, Centennial School. B.S., East Stroudsburg, 1980.

Robert E. Rosenwein (1972, 1975), associate professor of social psychology. B.A., Berkeley, 1962; M.A., 1963; Ph.D., Michigan, 1970.

Christine Roysdon (1974, 1979), head, reference division, Linderman Library. B.A., Arizona, 1970; M.S.L.S., Syracuse, 1974.

Renee J. Rozsa (1979), teacher, Centennial School. B.S., Penn State, 1978; M.Ed., Lehigh, 1981.

Herbert Rubenstein (1967, 1968), professor of philosophy and professor of human development. B.A., Pennsylvania, 1942; M.A., 1943; Ph.D., Columbia, 1949.

Carl R. Ruch (1977), director, health services. B.S., Muhlenberg, 1946; M.D., Pennsylvania, 1950.

J. Donald Ryan (1952, 1957), professor of geology. B.A., Lehigh, 1943; M.S., 1948; Ph.D., Johns Hopkins, 1952.

S

James S. Saeger (1967, 1976), associate professor of history, and coordinator, Lawrence Henry Gipson Institute for Eighteenth-Century Studies. B.A., Ohio State, 1960; M.A., 1963; Ph.D., 1969.

Eric P. Salathe (1967, 1980), professor, Center for the Application of Mathematics and director, division of bioengineering, Center for Health Sciences. Sc.B., Brown, 1960; M.S., Princeton, 1963; Ph.D., Brown, 1965.

Paul Salerni (1979), assistant professor of music, director, concert band, director, LUVME; director, electronic studio; B.A., Amherst, M.A., Harvard, 1975; Ph.D., 1979.

Kurt W. Salsburg (1981), assistant director, residence operations. A.B., Brown, 1977; M.P.A., New Hampshire, 1981.

Norman H. Sam (1962, 1970), professor of education, and director, summer sessions. B.S., Pittsburgh, 1951; M.Ed., 1955; Ed.D., 1962.

Steven Sametz (1979, 1980), assistant professor of music and director of the university choir. Dipl., Frankfurt Hochschule fur Musik und darstellende Kunst (Germany), 1975; B.A., Yale, 1976; M.A., Wisconsin, 1978; D.M.A., 1980.

Jeffrey A. Sands (1973, 1977), associate professor of physics. B.S., Delaware, 1969; M.S., Penn State, 1971; Ph.D., 1973.

Vicky L. Sanders (1979), admission counselor. B.S., S.U.N.Y. at Cortland, 1976.

Robert G. Sarubbi (1968, 1976), professor of mechanics. B.Sc.E., Cooper Union, 1953; M.S., Lehigh, 1957; Ph.D., 1963.

Kenneth N. Sawyers (1969, 1982), professor, Center for the Application of Mathematics. B.S., Illinois Inst. of Tech., 1962; Ph.D., Brown, 1967.

Harry C. Scarpa (1979), senior buyer. B.S., Penn State, 1970.

Murray Schechter (1963, 1978), professor of mathematics. A.B., Brooklyn, 1957; M.A., N.Y.U., 1959; Ph.D., 1964.

David Schenck (1980), assistant professor of religion studies. B.A., North Carolina at Chapel Hill, 1973; M.A., Duke, 1977; Ph.D., 1979.

Lorraine Scheibener (1982), student activities coordinator, office of the dean of students. B.A., Rutgers, 1980; M.Ed., Lehigh, 1982.

William E. Schiesser (1960, 1976), McCann Professor of Chemical Engineering. B.S., Lehigh, 1955; M.A., Princeton, 1958; Ph.D., 1960.

Donald W. Schmoyer (1946, 1962), assistant treasurer. B.S., Lehigh, 1944.

Jeffrey D. Schmoyer (1974, 1977), manager, Central Stores, office of institutional purchasing. A.A.S., Lehigh County Community, 1971.

Elia N. Schoomer (1974, 1977), media technician, media services. B.A., Lehigh, 1972; M.A., N.Y.U., 1974.

Keith J. Schray (1972, 1980), professor of chemistry, and director, division of biological chemistry and biophysics, Center for Health Sciences. B.S., Portland, 1965; Ph.D., Penn State, 1970.

Stanley R. Schultz (1966), varsity baseball coach. B.A., Trenton State, 1964.

Gregory J. Schulze (1979), director of intramurals and recreation. B.S., Penn State, 1969; M.S., 1975.

The Rev. Richard A. Schware (1976, 1979), chaplain, Newman Association. B.A., St. Charles Borromeo Seminary, 1971; M.Div., Mary Immaculate Seminary (Northampton, Pa.), 1975.

Eli Schwartz (1954, 1978), chairperson of economics and Charles W. Maclarlane Professor of Theoretical Economics. B.S., Denver, 1943; M.A., Connecticut, 1948; Ph.D., Brown, 1952.

Charles B. Sclar (1968), professor and chairperson of geological sciences. B.S., City College of N.Y., 1946; M.S., Yale, 1948; Ph.D., 1951.

Debra J. Seablom (1980), women's swimming coach. B.S., East Stroudsburg State, 1979.

Larry S. Sechney (1978, 1981), assistant director of career planning and placement services. A.A., Northampton County Community, 1972; B.S., Kutztown State, 1974.

Eugene R. Seeloff (1973, 1975), director of career planning and placement services. B.S., Ball State, 1967; M.A., 1972; Ed.D., 1974.

Linda T. Seeloff (1972, 1979), assistant to the president. B.A., Dickinson, 1971; M.Ed., Lehigh, 1977.

Carolyn F. Segal (1982), adjunct assistant professor of English. B.A., Rosary Hill, 1972; M.A., Lehigh, 1976; Ph.D., 1981.

Heidi L. Seitz (1980), programmer, administrative systems office. B.A., Bloomsburg, 1979.

Ram Sellamuthu (1981), research associate, metallurgy and materials engineering. B.S., U. of Madras (India), 1971; M.S., Indian Inst. of Science, 1973; Ph.D., Pittsburgh, 1979.

William G. Shade (1966, 1976), professor of history, and director of American Studies. A.B., Brown, 1961; M.A., 1962; Ph.D., Wayne State, 1966.

Olga L. Shaffer (1977), technical associate, Center for Surface and Coatings Research. B.S., Drexel, 1957; M.S., Lehigh, 1969.

Russell A. Shaffer (1964, 1967), associate professor of physics. B.S., Drexel, 1956; Ph.D., Johns Hopkins, 1962.

Ching Sheng Shen (1964, 1968), associate professor of economics. B.A., Yen-Ching (Peking), 1941; M.A., Boston U., 1951; Ph.D., North Carolina, 1957.

Robert F. Shoup (1979), planning associate, physical planning. B.F.A., Ohio Wesleyan, 1974.

George K. Shortess (1969. 1980), professor of psychology. A.B., Lycoming, 1954; M.A., Brown, 1960; Ph.D., 1960.

William J. Sibley (1964, 1977), counseling psychologist, counseling service. B.S., East Stroudsburg State, 1955; M.Ed., Lehigh, 1964.

Sharon L. Siegler (1971, 1981), head, Mart Public Services, Mart Library. B.A., Maine, 1969; M.L.S., New York at Albany, 1971.

George C. M. Sih (1958, 1965), professor of mechanics, and director, Institute for Fracture and Solid Mechanics. B.S., Portland, 1953; M.S., New York, 1957; Ph.D., Lehigh, 1960.

Cesar A. Silebi (1978), assistant professor of chemical engineering; Institute of Thermo-Fluid Engineering and Science. B.S., Universidad del Atlantico (Colombia), 1970; M.S., Lehigh, 1974; Ph.D., 1968.

Janet Simek (1982), accounting supervisor, office of the controller. B.A., Alvernia, 1978.

Gary W. Simmons (1970, 1980), professor of chemistry. B.S., West Virginia, 1961; Ph.D., Virginia, 1967.

Marvin H. Simmons (1970, 1975), associate director, office of university publications. B.A., Juniata, 1964; B.F.A. and M.F.A., Yale, 1970.

Roger D. Simon (1970, 1977), associate professor of history. A.B., Rutgers, 1965; M.A., Wisconsin, 1966; Ph.D., 1971.

Charles B. Simons (1982), professor and chairperson of aerospace studies. B.A., Trinity, 1955; M.S., U. of Southern California, 1970. Colonel, U.S.A.F.

Dale R. Simpson (1960, 1966), professor of geology. B.S., Penn State, 1956; M.S., Cal. Tech., 1958; Ph.D., 1960.

Kenneth P. Sinclair (1972, 1978), associate professor of accounting. B.A., Massachusetts, 1968; M.S., 1970; Ph.D., 1972.

Nadine Sine (1980), instructor of music. B.M.E., Temple, 1970; M.M., 1976.

Stephen Sivulich (1977), adjunct professor of education. B.A., Mount Union, 1963; M.A., Kent State, 1973; Ed.D., Lehigh, 1975.

Paul W. Sire (1979), director, administrative systems. B.A., St. John's U., 1959; M.B.A., 1965; M.A., Duke, 1973.

Zdenek J. Slouka (1972, 1977), professor of international relations. B.A., Masaryk (Czechoslovakia), 1948; M.A., N.Y.U., 1958; Ph.D., Columbia, 1965.

Roger G. Slutter (1961, 1975), professor of civil engineering, and director of operations, Fritz Engineering Laboratory. B.S., Lehigh, 1953; M.S., 1956; Ph.D., 1966.

Bruce M. Smackey (1971, 1977), associate professor of management and marketing. B.S., Rensselaer, 1962; M.S., Case-Western Reserve, 1964; Ph.D., Rensselaer, 1969.

Charles R. Smith (1978), professor of mechanical engineering and mechanics. B.S.M.E., Stanford, 1966; M.S.M.E., 1968; Ph.D., 1971.

Christine D. Smith (1980, 1983), director of corporate and foundation resources. B.A., Tulane, 1970; M.S., Purdue, 1974.

Gerald F. Smith (1965), professor and acting director, Center for the Application of Mathematics. B.S., Buffalo, 1953; Ph.D., Brown, 1956.

Janet L. F. Smith (1973, 1978), manager of telephone services. B.A., Bates, 1970.

Marion W. Smith (1983), adjunct assistant professor of chemistry. B.S., U. of Nottingham, 1964.

Wesley R. Smith (1958, 1979), professor of physics and coordinator, Sherman Fairchild Laboratory. B.S., Lehigh, 1950; M.S., 1951; Ph.D., Princeton, 1957.

Oles M. Smolansky (1963, 1966), professor of international relations. A.B., N.Y.U., 1953; A.M., Columbia, 1955; Ph.D., 1959.

Mervin P. Smolinsky (1970), adjunct associate professor of psychology and human development. B.A., Temple, 1951; M.S., Pittsburgh, 1966; Ph.D., 1969.

Donald M. Smyth (1971, 1973), director, Materials Research Center, and professor, metallurgy and materials engineering and chemistry. B.S., Maine, 1951; Ph.D., M.I.T., 1954.

Michael W. Snovitch (1982), adjunct lecturer in electrical and computer engineering. B.S., Penn State, 1968; M.S., Lehigh, 1973.

Andrew K. Snyder (1961, 1980), professor of mathematics. B.A., Swarthmore, 1959; M.A., Colorado, 1961; Ph.D., Lehigh, 1965.

Warren G. Soare (1979), associate dean of students. B.A., Miami U. of Ohio, 1970; M.Div., Princeton Theological Seminary, 1974; Ed.D., Columbia. 1979.

Bruce R. Somers (1980), research engineer, metallurgy and materials engineering. B.S., Rensselaer, 1969; M.S., Virginia Polytechnic Inst., 1976; Ph.D., Lehigh, 1980.

Robert M. Sorensen (1982), professor of civil engineering. B.S., New Jersey Inst. of Tech., 1960; M.S., Lehigh, 1962; Ph.D., California (Berkeley), 1966.

Lydia A. Speller (1982), assistant professor of religion studies. B.A., Bryn Mawr, 1975; D.Phil., Somerville College, Oxford, 1980.

Leslie H. Sperling (1967, 1978), professor of chemical engineering. B.S., Florida, 1954; M.A., Duke, 1957; Ph.D., 1959.

Robert S. Sprague (1957, 1981), professor and assistant chairperson of chemistry. B.S., Washington & Jefferson, 1943; Ph.D., Illinois, 1949.

Robert A. Spurgeon (1978), adjunct lecturer in electrical and computer engineering. B.S., Purdue, 1961; M.S., 1965.

Duane E. Stackhouse (1969), associate director, health services. B.S., Juniata, 1957; M.D., Temple, 1961.

William B. Stafford (1967, 1972), associate professor of human development. A.B., Ohio, 1954; M.A., 1955; Ed.D., Indiana, 1965.

Ronald Stankiewicz (1978), assistant professor of aerospace studies. B.A., Montclair State, 1970; M.B.A., North Dakota, 1974. Major, U.S.A.F.

William E. Stanford (1967, 1970), director of financial aid. B.A., Drew, 1962.

Lee J. Stanley (1982), assistant professor of mathematics. A.B., Princeton, 1971; M.A., Berkeley, 1973; Ph.D., 1977.

Maryse Stanley (1983), adjunct lecturer of modern foreign languages. B.S., Lycee de Compiegne, 1967.

Lamont F. Steedle (1977, 1978), assistant professor of accounting. B.S., Penn State, 1968; M.S., 1974; Ph.D., 1978. C.M.A., 1982.

Fred P. Stein (1963, 1971), professor of chemical engineering. B.S., Lehigh, 1956; M.S.E., Michigan, 1957; Ph.D., 1960.

Olive Stengel (1963, 1966), head, circulation service, university libraries.

Gilbert A. Stengle (1960, 1970), professor of mathematics. B.E.P., Cornell, 1954; M.S., Wisconsin, 1957; Ph.D., 1961.

Kyra D. Stephanoff (1982), assistant professor of mechanical engineering and mechanics. B.S., Pennsylvania, 1977; D.Phil., Oxford, 1982.

Joseph D. Sterrett (1978), assistant football coach. B.A., Lehigh, 1976; M.Ed., 1978.

John E. Stevens (1975, 1981), associate professor of management, and associate director, Small Business Center. B.S., Dayton, 1968; M.B.A., 1970; M.A., Cincinnati, 1974; Ph.D., 1975.

John A. Stoops (1959, 1980), adjunct distinguished professor of educational philosophy. B.S., California State, 1948; M.S., Pennsylvania, 1949; Ed.D., 1960.

Richard B. Streeter (1979), director, Office of Research. B.A., Florida, 1962; M.Ed., 1963; Ed.D., Miami, 1972.

Stinson W. Stroup (1979), assistant professor of education. A.B., Illinois, 1970; M.S.Ed., Northern Illinois, 1976; J.D., Chicago, 1973.

James E. Sturm (1956, 1972), professor of chemistry. B.A., St. John's (Minnesota), 1951; Ph.D., Notre Dame, 1957.

Robert J. Sullivan (1962, 1969), professor and head of journalism. B.A., Syracuse, 1947; M.A., 1951.

Robert J. Suppa (1979), assistant professor of education. B.S., Edinboro State Coll., 1966; M.Ed., 1968, 1971; Ed.D., Kentucky, 1981.

Kimberley S. Sursa (1979), teacher, Centennial School. B.S., Cedar Crest, 1978; M.Ed., Lehigh, 1981.

Alfred K. Susskind (1968), professor of electrical and computer engineering. B.E.F., Brooklyn Polytechnic, 1948; S.M., M.I.T., 1950.

Hugh T. Sutherland (1967), instruments associate, Fritz Engineering Laboratory.

Ronald J. Szabo (1982), adjunct lecturer of administration and supervision. B.A., Montclair State, 1968; M.A., Lehigh, 1972.

Susan Szczepanski (1982), assistant professor of mathematics. B.A., LaSalle, 1975; Ph.D., Rutgers, 1980.

T

Donald T. Talhelm (1960, 1982), associate professor of electrical engineering. B.S., Lehigh, 1959; M.S., 1960.

Barbara J. Tallarico (1973), administrative assistant, community relations.

Ruth Tallman (1982), director of CAD/CAM affiliates program. B.A., Penn State, 1974.

Keisuke Tanaka (1981), associate professor of mechanical engineering and mechanics. B.S., Kyoto U. (Japan), 1966; M.S., 1968; Ph.D., 1972.

S. Kenneth Tarby (1961, 1973), professor of metallurgy and materials engineering. B.S., Carnegie-Mellon, 1956; M.S., 1958; Ph.D., 1962.

M. Orhan Tarhan (1982), adjunct professor of chemical engineering. M.S., Technical Universities of Dormstadt and Dresden, 1943.

Merle W. Tate (1982), adjunct professor of human development. A.B., Central Wesleyan, 1926; M.A., Montana, 1943; Ed.M., Harvard, 1946; Ed.D., 1947.

Linda L. Taylor (1981), admission counselor. B.A., Lehigh, 1981.

Theodore A. Terry (1951, 1968), associate professor of mechanical engineering. B.S., Drexel, 1950; M.S., Lehigh, 1951; Ph.D., 1963. P.E., Pennsylvania, 1957.

Stephen F. Thode (1982), assistant professor of finance. B.A., Coe, 1973; M.B.A., Indiana, 1979; D.B.A., 1980.

David A. Thomas (1968, 1970), professor of metallurgy and materials engineering, and associate director, Materials Research Center. B.S., Cornell, 1953; Sc.D., M.I.T., 1958.

Robert J. Thornton (1970, 1981), professor of economics. A.B., Xavier, 1965; M.A., Illinois, 1967; Ph.D., 1970.

Ferdinand Thun (1973, 1983), director for planned giving. B.S., Lehigh, 1956; M.B.A., Harvard, 1960.

James A. Tiefenbrunn (1975, 1980), director of budget. B.S., Lehigh, 1966; M.B.A., 1972.

C. Leon Tipton (1964, 1971), professor and chairman of history. B.A., U.S.C., 1958; M.A., 1961; Ph.D., 1964.

James W. Tobak (1977), assistant professor of law. B.A., Lehigh, 1968; M.A., Stanford, 1972; J.D., 1972.

Lori J. Toedter (1979, 1980), research scientist, Center for Social Research. B.A., Lehigh, 1976; M.A., 1977.

Robert P. Torpey (1975, 1978), principal, Centennial School. B.S., East Stroudsburg State, 1973; M.Ed., Lehigh, 1980.

Barbara H. Traister (1973, 1979), associate professor of English. B.A., Colby, 1965; M.Phil., Yale, 1968; Ph.D., 1973.

Doris M. Transue (1964), nurse, health services. R.N., St. Luke's Hospital, 1947.

Walter W. Trimble (1978), assistant professor of journalism. B.A., Ohio State, 1970; M.A., 1972.

Barbara A. Turanchik (1980, 1981), assistant executive director, alumni association. B.A., Lehigh, 1975.

B. Thayer Turner (1970), varsity wrestling coach. B.S., Lehigh, 1961.

John C. Turoczi (1980), adjunct assistant professor of human development. A.B., Muhlenberg, 1964; M.Ed., Lehigh, 1967; Ed.D., 1972.

LeRoy J. Tuscher (1971, 1982), professor of education. B.S., Northern State, 1958; M.A., Stanford, 1964; Ph.D., Florida State, 1971.

Kemal Tuzia (1982), research engineer, Institute of Thermo-Fluid Engineering and Science. M.S., Tech. Inst. of Istanbul, 1966; Ph.D., 1972.

Kenneth K. Tzeng (1969, 1977), professor of electrical and computer engineering. B.S., National Taiwan (Taiwan), 1959; M.S., Illinois, 1962; Ph.D., 1969.

U

Ravindras Upadhye (1981), adjunct associate professor of chemical engineering. B.Tech., Indian Inst. of Tech. (Bombay), 1969; M.S., U. of New Brunswick (Canada), 1969; Ph.D., Berkeley, 1974.

Dean P. Updike, (1965, 1980), professor of mechanics. B.S., Princeton, 1957; M.S., N.Y.U., 1960; Ph.D., Brown, 1964.

Paul J. Usinowicz (1972, 1978), associate professor of civil engineering. B.S., Iowa, 1968; M.S., 1969; Ph.D., Michigan, 1972. P.E., Pennsylvania, 1974.

V

Victor M. Valenzuela (1957, 1969), professor of Spanish and Latin-American studies. B.A., San Francisco State, 1951; M.A., Columbia, 1952; Ph.D., 1965.

John W. Vanderhoff (1970, 1974), professor of chemistry and director, National Printing Ink Research Institute; associate director, Center for Surface and Coatings Research; and co-director, Emulsion Polymers Laboratory. B.S., Niagara, 1947; Ph.D., Buffalo, 1951.

Anje C. van der Naald (1969, 1973), associate professor of Spanish. B.A., Carleton (Ottawa), 1963; M.A., Illinois, 1965; Ph.D., 1967.

John A. Van Eerde (1960, 1963), professor of romance languages. A.B., Harvard, 1938; M.A., 1939; Ph.D., Johns Hopkins, 1953.

David A. VanHorn (1962, 1967), professor and chairperson of civil engineering. B.S., Iowa State, 1951; M.S., 1956; Ph.D., 1959; P.E., Iowa, 1957.

Wesley J. Van Sciver (1962, 1965), professor of physics. B.S., M.I.T., 1940; Ph.D., Stanford, 1954.

Chester J. Van Tyne (1982), adjunct assistant professor of metallurgy. B.S., Lehigh, 1974; B.A., 1974; M.S. (metallurgy and materials science), 1976; M.S. (chemical engineering), 1978; Ph.D., 1980.

Eric Varley (1967), professor, Center for the Application of Mathematics. B.Sc., Manchester (England), 1955; M.Sc., 1957; Ph.D., Brown, 1961.

Madhumati V. Vaze (1982), systems programmer, Computing Center. B. of Commerce, U. of Bombay (India), 1980.

Ramamirthan Venkataraman (1968, 1974), associate professor, Center for the Application of Mathematics; Institute of Thermo-Fluid Engineering and Science. B.S., St. Joseph's (India), 1960; M.A., 1961; Ph.D., Brown, 1968.

Kenneth J. Veprek (1968), technical coordinator—serials, university libraries. B.S., Newark Col. of Engr., 1953; M.S.L.S., Drexel, 1966.

Thomas J. Verbonitz (1966, 1973), director of personnel and administrative services. B.S., Lehigh, 1958; M.B.A., 1960.

John F. Vickrey (1961, 1974), professor of English. Ph.B., Chicago, 1949; A.M., 1952; Ph.D., Indiana, 1960.

Ricardo Viera (1974, 1978), associate professor of art, director/curator of the Lehigh University Art Galleries. Dipl., Boston Museum School, 1973; B.F.A., Tufts, 1973; M.F.A., Rhode Island School of Design, 1974.

Charles H. Voas (1982), assistant professor of mathematics. B.A., Dartmouth, 1975; M.S., North Texas State, 1976; Ph.D., Virginia, 1980.

Robert Vogel (1980), research associate, Sherman Fairchild Laboratory. B.S., Michigan, 1974; M.S., 1977; Ph.D., 1980.

Weston C. Vogel, Jr. (1982), adjunct lecturer of industrial engineering. B.S., Lehigh, 1976.

Stephen J. Volle (1980), teacher, Centennial School. B.S., Juniata, 1976; M.Ed., Lehigh, 1980.

W

James H. Wagner (1949, 1951), registrar. B.A., Gettysburg, 1947; M.A., Pennsylvania, 1950.

Ronald Wagner (1979), programmer, administrative systems. B.S., Penn State, 1974; A.A., Northampton County Comm. Coll., 1979.

D. Alexander Waldenrath (1968, 1969), associate professor of German. Ubersetzer diplom, U. of Vienna (Austria), 1959. B.A., Berkeley, 1961; M.A., 1964; Ph.D., 1969.

Alfred T. Walker, III (1981), research associate, Materials Research Center. B.S., Rutgers, 1967; M.S., Columbia, 1974.

J. David Walker (1978), professor of mechanical engineering and mechanics. B.A., Western Ontario (Canada), 1967; M.Sc., 1968; Ph.D., 1971.

Elvin G. Warfel (1966, 1971), associate professor of education. B.S., Shippensburg State, 1950; M.Ed., Penn State, 1958; Ed.D., Columbia, 1967.

Arthur S. Warnock (1981), research engineer, Energy Research Center. B.S., Drexel, 1963; M.S., 1965; Ph.D., 1975.

George D. Watkins (1975), Sherman Fairchild Professor of Solid-State Studies. B.S., Randolph-Macon, 1943; A.M., Harvard, 1947; Ph.D., 1952.

Roger Watkins (1980), assistant dean of students. B.S., Boston State, 1974; M.A., Tufts, 1980.

Stuart K. Webster (1972, 1979), associate professor and chairman, accounting and law. B.A., Heidelberg, 1964; M.B.A., Bowling Green, 1965; Ph.D., Iowa, 1975; C.P.A., Iowa, 1969.

Fred J. Wehden (1977), laboratory and shop supervisor, mechanical engineering and mechanics.

Robert P. Wei (1966, 1970), professor of mechanics. B.S., Princeton, 1953; M.S., 1954; Ph.D., 1960.

Kevin R. Weiner (1982), educational coordinator, Computing Center. B.A., Lehigh, 1978.

Richard N. Weisman (1977, 1980), associate professor of civil engineering. B.S., Cornell, 1967; M.S., 1968; Ph.D., 1973.

David E. Welty (1978), assistant director, personnel office. B.A., Moravian, 1972.

Christine A. Wendland (1981), teacher, Centennial School. B.S., Kutztown, 1980.

Frederic W. West III (1980), director, Centennial School. B.S., Tennessee, 1972; M.S., 1975; Ed.S., Kent State, 1978.

June West (1980, 1982), adjunct lecturer, management, finance and marketing. B.S., Tennessee, 1972; M.Ed., Kent State, 1977.

Leonard A. Wenzel, (1951, 1962), professor and chairman of chemical engineering. B.S., Penn State, 1943; M.S., Michigan, 1948; Ph.D., 1950. P.E., Pennsylvania, 1958.

Annie-Laurie Wheat (1981), assistant professor of theater. B.A., Tusculum College, 1971; M.F.A., Georgia, 1973.

Donald B. Wheeler, Jr. (1947, 1979), professor of physics. B.S., Lehigh, 1938; Ph.D., Cal. Tech., 1947.

Howard R. Whitcomb (1967, 1981), professor and chairperson of government. A.B., Brown, 1961; M.A., Lehigh, 1963; Ph.D., S.U.N.Y. at Albany, 1971. (On academic leave, spring, 1983)

Muriel A. Whitcomb (1975, 1976), assistant dean of students. B.A., Stanford, 1962; M.A., Cornell, 1968.

Marvin H. White (1981), Sherman Fairchild Professor of Solid-State Studies. B.S., 1960; M.S., Michigan, 1961; Ph.D., Ohio State, 1969.

Sophia W. White (1982), adjunct lecturer of electrical and computer engineering. B.S., College of Charleston, 1961; M.S., Johns Hopkins, 1973.

John C. Whitehead (1967, 1976), varsity football coach. B.S., East Stroudsburg State, 1950.

Walter J. Whitehead (1976), assistant football coach. B.S., Purdue, 1970.

Joseph H. Whritenour (1965), assistant director of public information.

Albert Wilansky (1948, 1978), University Distinguished Professor of Mathematics. B.A., Dalhousie (Canada), 1941; B.Sc., 1942; M.A., 1944; Ph.D., Brown, 1947.

David B. Williams (1976, 1979), associate professor of metallurgy and materials engineering. B.A., Christ's Cambridge (England), 1967; M.A., Cambridge, 1973; Ph.D., 1974.

Craig E. Williamson (1981), assistant professor of biology. B.A., Dartmouth, 1975; M.A., Mount Holyoke, 1977; Ph.D., Dartmouth, 1981.

Robert C. Williamson (1963, 1964), professor of sociology. B.A., U.C.L.A., 1938; M.A., 1940; Ph.D., U.S.C., 1951.

George R. Wilson (1978), assistant professor of industrial engineering. B.S., Penn State, 1971; M.S., 1973; Ph.D., 1979.

John L. Wilson (1982), associate professor of civil engineering. B.S., Tufts, 1963; M.Eng., Yale, 1964; Ph.D., Pittsburgh, 1972.

Lenora D. Wolfgang (1980), assistant professor of French. B.A., Pennsylvania, 1956; M.A., 1965; Ph.D., 1973.

Gina V. Wolfe (1982), teacher intern, Centennial School. B.S., Bloomsburg State, 1982.

John W. Woltjen (1977), vice president and treasurer. B.S., Moravian, 1959.

John D. Wood (1960, 1978), professor of metallurgy and materials engineering. B.S., Case-Western Reserve, 1953; M.S., Lehigh, 1959; Ph.D., 1962.

Anthony L. Woolum (1982), administrative specialist, military science. Sergeant First Class, U.S. Army.

Bradley W. Wyckoff (1980), head men's tennis coach. B.A., Lehigh, 1980.

Raymond F. Wylie (1973, 1980), associate professor of international relations. B.A., Toronto (Canada), 1964; M.A., 1968; Ph.D., London (England), 1976.

Y

W. Ross Yates (1955, 1963), professor of government. B.A., Oregon, 1948; M.A., 1949; Ph.D., Yale, 1956.

Kenneth M. Yeisley (1974), assistant director, physical plant.

Ben Tseng Yen (1957, 1977), professor of civil engineering. B.S., National Taiwan (Taiwan), 1955; M.S., Lehigh, 1959; Ph.D., 1963.

Donald R. Young (1982), adjunct professor of physics. B.S., Utah State, 1942; Ph.D., M.I.T., 1949.

Thomas E. Young (1958, 1966), professor of chemistry. B.S., Lehigh, 1949; M.S., 1950; Ph.D., Illinois, 1952.

Z

Daniel Zeroka (1967, 1974), associate professor of chemistry. B.S., Wilkes, 1963; Ph.D., Pennsylvania, 1966.

Emory W. Zimmers, Jr. (1969, 1980), professor of industrial engineering. B.S., Lehigh, 1966; B.S., 1967; M.S., 1967; Ph.D., 1973.

Berkley Zionts (1983), adjunct professor of accounting and law. B.S., Duquesne, 1953; J.D., U. of Pittsburgh School of Law, 1959.

Perry A. Zirkel (1977), dean of the School of Education, and professor of education. B.A., S.U.N.Y. at Oswego, 1966; M.A., Connecticut, 1968; Ph.D., 1972; J.D., 1976.

Bruce K. Zophy (1981), assistant professor of military science. B.S., West Point, 1976. Captain, U.S. Army.

Faculty and Staff Emeriti

The first year given is the year in which the person commenced employment with Lehigh University. In some cases, individuals left and returned, so that an additional date is given. The final date in all cases is the year in which the person achieved emeritus/emerita status.

Eugene M. Allen (1967, 1982), professor emeritus of chemistry. B.A., Columbia, 1938; M.S., Stevens Inst. of Tech., 1944; Ph.D., Rutgers, 1952.

Edward D. Amstutz (1938, 1972), Howard S. Bunn Distinguished Professor Emeritus of Chemistry. B.S., Wooster, 1930; M.S., Inst. of Paper Chemistry, 1932; Ph.D., Cornell, 1936; D.Sc., Wooster, 1969.

Ray L. Armstrong (1946, 1975), professor emeritus of English. B.A. Williams, 1930; B.A., Oxford, 1932; M.A., 1936; Ph.D., Columbia, 1941.

Lloyd W. Ashby (1966, 1971), professor emeritus of education. A.B., Hastings (Nebraska), 1927; M.A., Columbia Teachers, 1935; Ed.D., 1950.

Allen J. Barthold (1939, 1967), professor emeritus of romance languages. B.A., Lehigh, 1921; Ph.D., Yale, 1931.

Josef M. Brozek (1959, 1979), research professor emeritus of psychology. Ph.D., Charles (Prague), 1937.

Natt B. Burbank (1964, 1971), professor and assistant dean emeritus, School of Education. A.B., Vermont, 1925; M.A., Columbia, 1931; LL.D., Vermont, 1963.

Clarence B. Campbell (1947, 1957, 1974), dean emeritus of residence. B.A., Temple, 1937; M.A., Lehigh, 1947.

Glenn J. Christensen (1939, 1976), University Distinguished Professor Emeritus. B.A., Wooster, 1935; Ph.D., Yale, 1939; LL.D., Col., of Notre Dame (Maryland), 1966.

Raymond G. Cowherd (1956, 1975), professor emeritus of history. A.B., William Jewell, 1933; M.A., Pennsylvania, 1936; Ph.D., 1940.

Cloyd Criswell (1947, 1973), professor emeritus of English. B.S., in Ed., Millersville State, 1933; M.A., N.Y.U., 1937.

Cassius W. Curtis (1946, 1971), professor emeritus of physics. A.B., Williams, 1928; Ph.D., Princeton, 1936.

Edward H. Cutler (1930, 1968), associate professor emeritus of mathematics. A.B., Harvard, 1925; A.M., 1926; Ph.D., 1930.

Robert B. Cutler (1954, 1979), professor emeritus of music. A.B., Bucknell, 1934; M.A., Columbia, 1935.

H. Barrett Davis (1946, 1972), professor emeritus of speech. B.L.I., Emerson, 1929; Cert., American Academy of Dramatic Arts, 1930; M.A. (Hon.), Emerson, 1958.

Edna S. de Angeli (1963, 1982), professor emerita of classics. B.S., Temple, 1938; M.A., Pennsylvania, 1960; Ph.D., 1965.

Margaret L. Dennis (1953, 1982), assistant librarian emerita for bibliographical services, Linderman Library. A.B., Allegheny, 1939; B.S. in L.S., Syracuse, 1940.

Ernest N. Dilworth (1949, 1975), professor emeritus of English. Ph.B., Kenyon, 1933; M.A., Pittsburgh, 1937; Ph.D., Columbia, 1948.

A. Roy Eckardt (1951, 1980), professor emeritus of religion studies. B.A., Brooklyn, 1942; M.Div., Yale, 1944; Ph.D., Columbia, 1947; L.H.D., Hebrew Union, 1969.

James V.D. Eppes (1950, 1974), professor emeritus of mechanical engineering. B.A., Virginia, 1928; M.E., Cornell, 1931; M.S. in M.E., Lehigh, 1943.

Alan S. Foust (1952, 1976), professor emeritus of chemical engineering. B.S., Texas, 1928; M.S., 1930; Ph.D., Michigan, 1938. P.E., Michigan, 1947.

Frederick M. Fowkes (1968, 1982), professor emeritus of chemistry. B.S., Chicago, 1936; Ph.D., 1938.

Matthew W. Gaffney (1971, 1979), professor emeritus of education. A.B., Hobart, 1935; M.A., Rochester, 1941; Ed.D., Buffalo, 1953.

Elmer W. Glick (1949, 1978), vice president and treasurer emeritus. B.A., Lehigh, 1933; LL.D., (Hon.), 1978.

Margaret C. Grandovic (1962, 1982), associate professor emerita of education. B.S., Temple, 1938; M.Ed., 1957; Ed.D., 1968.

Theodore Hailperin (1946, 1980), professor emeritus of mathematics. B.S., Michigan, 1939; Ph.D., Cornell, 1943.

Robert A. Harrier (1951, 1970), executive secretary emeritus, alumni association. E.M., Lehigh, 1927.

Ladd E. Hoover (1960, 1967), associate director emeritus, university health services. B.Sc., Nebraska, 1924; M.D., 1926.

Thomas E. Jackson (1946, 1978), professor emeritus of mechanical engineering and mechanics, B.S., Carnegie-Mellon, 1934; M.S., Lehigh, 1937. P.E., Pennsylvania, 1946.

George R. Jenkins (1948, 1980), director emeritus, Office of Research. B.A., Colorado, 1936; Ph.M., Wisconsin, 1938.

Finn B. Jensen (1947, 1979), Charles Macfarlane Professor of Economics Emeritus. A.B., U.S.C., 1934; M.A., 1935; Ph.D., 1940.

John J. Karakash (1946, 1966), Distinguished Professor Emeritus of Electrical and Computer Engineering and dean emeritus of the College of Engineering and Physical Sciences. B.S., Duke, 1937; M.S., Pennsylvania, 1938; Eng.D. (Hon.), Lehigh, 1971. P.E., Pennsylvania, 1948.

Edwin J. Keim (1973, 1976), associate professor emeritus of education. B.S., West Chester State, 1934; M.S., Pennsylvania, 1940; Ed.D., 1951.

John L. Kemmerer (1966, 1979), purchasing agent emeritus.

Leon E. Krouse (1951, 1963), associate professor emeritus of finance, B.S., Susquehanna, 1941; M.S., Bucknell, 1947; Ph.D., New York, 1958.

Nancy Larrick (1964, 1976), adjunct professor emerita of education. B.A., Goucher, 1930; M.A., Columbia, 1937; Ed.D., N.Y.U., 1955.

Voris V. Latshaw (1931, 1969), associate professor emeritus of mathematics. B.A., Indiana, 1927; A.M., 1928; Ph.D., 1930.

Gerald G. Leeman (1950, 1982), assistant to the director emeritus of intercollegiate athletics and recreation. B.A., Iowa State, 1948.

John D. Leith (1945, 1964, 1966), dean of students emeritus. A.B., North Dakota, 1920; A.M., Columbia, 1924.

Deming Lewis (1964, 1982), president emeritus. A.B., Harvard, 1935; B.A., Oxford (England), 1938; M.A., Harvard, 1939; Ph.D., Harvard, 1941; M.A., Oxford, 1945; LL.D., Lafayette, 1965; L.H.D., Moravian, 1966; L.H.D. Rutgers, 1966; LL.D., Muhlenberg, 1968; D.Sc., Medical College of Pennsylvania, 1972; Eng.D., Lehigh, 1974.

James D. Mack (1946, 1978), professor and curator emeritus of rare books. B.A., Lehigh, 1938; M.A., 1949.

James P. Mathews (1947, 1978), physiotherapist emeritus.

Joseph A. Maurer (1947, 1977), professor emeritus of classics. B.A., Moravian, 1932; M.A., Lehigh, 1936; Ph.D., Pennsylvania, 1948.

Ethel M. McCormick (1964, 1969), associate professor emerita of education. B.S., Northwestern 1931; M.Ed., Penn State, 1941; D.Sc.Ed., Cedar Crest, 1963.

Charles A. McCoy (1968, 1982), professor emeritus of government. B.S.Ed., Illinois, 1948; M.A., Colgate, 1950; Ph.D., Boston, 1958.

George W. McCoy, Jr. (1956, 1970), university physician emeritus. B.S., Pennsylvania, 1929; M.D., 1932.

Joseph B. McFadden (1948, 1982), professor emeritus of journalism. B.A., St. Joseph's (Canada), 1941; M.A., Syracuse, 1948.

Albert C. Molter (1960, 1974), purchasing agent emeritus. B.S., Norwich, 1928.

Harvey A. Neville (1927, 1964), president emeritus. A.B., Randolph-Macon, 1918; M.A., Princeton, 1920; Ph.D., 1921; LL.D. (Hon.), Lafayette, 1962; Sc.D. (Hon.), Lehigh, 1965.

Joseph C. Osborn (1955, 1977), professor emeritus of mechanics. B.S.M.E., Purdue, 1933; M.S., Michigan, 1946.

Bradford B. Owen (1945, 1974), professor emeritus of biology. B.A., Williams, 1934; M.A., 1936; Ph.D., Harvard, 1940.

Preston Parr (1949, 1982), dean emeritus and vice president emeritus for student affairs. B.S., Lehigh, 1943; M.S., 1944.

A. Everett Pitcher (1938, 1978), University Distinguished Professor Emeritus of Mathematics. A.B., Case-Western Reserve, 1932; A.M., Harvard, 1933; Ph.D., 1935; D.Sc., (Hon.), Case-Western Reserve, 1957.

Estoy Reddin (1964, 1977), professor emeritus of education. B.S., Pennsylvania, 1932; M.S., 1956; Ed.D., 1964.

Ronald S. Rivlin (1967, 1980), University Professor Emeritus. B.A., Cambridge (England), 1937; M.A., 1939; Sc.D., 1952.

Raymond B. Sawyer (1946, 1964), associate professor emeritus of physics. Ph.B., Ripon, 1921; M.S., Wisconsin, 1925; Ph.D., Chicago, 1930.

Ernst B. Schulz (1927, 1965), professor emeritus of political science. B.S., Michigan, 1920; M.A., 1921; Ph.D., 1927.

Edith A. Seifert (1923, 1969), bursar emerita.

J. Burke Severs (1927, 1969), Distinguished Professor Emeritus of English. A.B., Rutgers, 1925; A.M., Princeton, 1927; Ph.D., Yale, 1935; Fellow of the Royal Society of Arts, 1962.

Margaret M. Seylar (1966, 1977), professor emerita of education. B.S., Kutztown, 1947; M.A., Lehigh, 1957.

E. Kenneth Smiley (1934, 1964), vice president emeritus. A.B., Bowdoin, 1921; M.A., Lehigh, 1935; L.H.D., (Hon.), Moravian, 1947; LL.D. (Hon.), Waynesburg, 1952.

Max D. Snider (1946, 1980), professor emeritus of marketing and associate dean emeritus of the College of Business and Economics. B.S., Illinois, 1936; M.S., 1937; M.B.A., Stanford, 1941.

Wilbur D. Bernhart Spatz (1946, 1973), professor emeritus of physics. B.S., Lafayette, 1930; M.S., Purdue, 1934; Ph.D., N.Y.U., 1943.

Robert D. Stout (1939, 1980), dean emeritus and professor emeritus of metallurgy and materials engineering. B.S., Penn State, 1935; M.S., Lehigh, 1941; Ph.D., 1944; D.Sc., Albright, 1967. P.E., Pennsylvania, 1946.

Carl F. Strauch (1934, 1974), Distinguished Professor Emeritus of English. A.B., Muhlenberg, 1930; M.A., Lehigh, 1934; Ph.D., Yale, 1946; D.H.L. (Hon.), Muhlenberg, 1973.

Merle W. Tate (1965, 1974), professor emeritus of education. A.B., Central Wesleyan, 1962; M.A., Montana, 1943; Ed.M., Harvard, 1946; Ed.D., 1947.

Everett A. Teal (1945, 1975), director emeritus of placement services. B.S., Ball State, 1932; M.A., Columbia, 1941.

L. Reed Tripp (1964, 1979), Frank L. Magee Professor Emeritus of Business Administration. B.A., Union, 1934; Ph.D., Yale, 1942.

Wendell P. Trumbull (1957, 1974), professor emeritus of accounting. B.S., Illinois. 1937; M.A., Michigan, 1941; Ph.D., 1954, C.P.A., Mississippi, 1949.

Ben L. Wechsler (1974, 1982), professor emeritus of industrial engineering. B.S., Carnegie, 1942; M.A., George Washington, 1962; Ph.D., Lehigh, 1974.

Lawrence Whitcomb (1930, 1965), associate professor emeritus of geology. Ph.B., Brown, 1922; A.M., Princeton, 1928; Ph.D., 1930.

Ralph C. Wood (1958, 1967), professor emeritus of German. B.A. and B.E., Cincinnati, 1928; M.A., 1930; Ph.D., Cornell, 1933.

Albert C. Zettlemoyer (1941, 1982), Distinguished Professor Emeritus of Chemistry; provost and vice president emeritus. B.S., Lehigh, 1936; M.S., 1938; Ph.D., M.I.T., 1941; D.Sc., Clarkson, 1965; LL.D., The China Academy (Taiwan), 1974.

In Memoriam

The university records with regret the deaths of the following individuals during the past two years.

Carl F. Allen, professor emeritus of accounting, August 31, 1981.

Robert D. Billinger, associate professor emeritus of chemistry, October, 1980.

Charles W. Brennan, dean of students emeritus, and professor emeritus of industrial engineering.

Warren M. Davis, lecturer emeritus of education, May 3, 1981.

Albert W. de Neufville, associate professor emeritus of mechanics, May 10, 1981.

Herbert F. Diamond, professor emeritus of economics, March, 1982.

William J. Eney, Joseph T. Stuart Professor Emeritus of Civil Engineering.

Robert T. Gallagher, professor emeritus of mining engineering; associate dean emeritus, College of Engineering and Physical Sciences, October 12, 1982.

Edgar H. Riley, associate professor emeritus of English, April 26, 1982.

Charles A. Seidle, vice president emeritus, April 27, 1982.

Earl J. Serfass, former professor and chairman of the chemistry department, November 24, 1982.

Recognition of Achievement

At the end of each semester, the dean of students publishes a list of all regular undergraduates who during that semester achieved a scholastic average of 3.50 or better and carried at least twelve credit hours of regularly graded courses (A, B, C, D, F). This is the dean's list.

Other student prizes and awards are announced at commencement exercises on Founder's Day, the second Sunday in October, and on University Day in May or June. A description of prizes and awards follows.

Alumni Association Prizes. Funds are provided by the alumni association for three prizes of $25 each. Prizes are awarded annually to the highest-ranking juniors in each undergraduate college.

Medal of the Philadelphia Chapter, American Institute of Chemists. This medal is awarded to the academically highest ranking senior majoring in chemistry or chemical engineering.

American Society for Testing Materials Student Memberships Prize. The ASTM awards four student memberships each year to students who in their junior year have demonstrated interest and meritorious work in the engineering courses that are related to the ASTM.

Bethlehem Fabricators Award. This tuition award is made to the junior who has shown the most improvement in academic achievement over previous years.

The Robert W. Blake Memorial Prize. This prize is awarded annually at Founder's Day exercises to a freshman who has completed one year of studies in the College of Arts and Science and who is recommended by the college faculty as the most outstanding in high scholastic achievement and in promise of worthy leadership.

Nelson Leighton Bond 1926 Memorial Award. This award is made to an outstanding sophomore on the basis of character, leadership and scholastic achievement but not financial need. Nelson L. Bond was a prominent alumnus.

The John B. Carson Prize. An annual prize was established by Mrs. Helen Carson Turner, of Philadelphia, in memory of her father, John B. Carson, whose son, James D. Carson, was a graduate of the civil engineering curriculum in 1876. It is awarded to the senior in civil engineering who shows the most marked excellence in professional courses.

The William H. Chandler Prizes in Chemistry. Four annual prizes, one in each class, for excellence in the chemistry and chemical engineering curricula were established by Mrs. Mary E. Chandler, widow of Dr. William H. Chandler, who was professor of chemistry at Lehigh from 1871 until his death in 1906.

The N.I. Stotz and D.E. Rickert Choral Cup. The choral cup provided by Norman I. Stotz, Jr., '53, and Donald E. Richert, '53, is awarded to the outstanding senior participating in the choral organizations of the music department.

The R.K. Burr and J.D. Kirkpatrick Concert Cup. The concert cup provided by Richard K. Burr, '53, and J. Donald Kirkpatrick, '55, is awarded to the outstanding senior(s) participating in the band or other instrumental organizations of the music department.

The Cornelius Prize. The Cornelius Prize established by William A. Cornelius, M.S. 1889, and endowed by a bequest by his widow, Mrs. Eleanor R.W. Cornelius, is awarded annually to the senior student in mechanical engineering who is judged to have profited most by opportunities at Lehigh. The award is based 70 percent on scholarship, 20 percent on attainment in general culture, and 10 percent on development in personality. To be

eligible for the award, a student's scholastic standing must be in the top quarter of the class in the College of Engineering and Physical Sciences.

Robert Cutler Senior Cup. To a senior member of the choir for his or her outstanding service to the choir.

Aurie N. Dunlap Prize in International Relations. The prize is to be awarded yearly by the international relations department to an outstanding senior in international relations. Among the criteria used to select the winner (or winners) are the following: cumulative average in international relations courses (minimum 3.5 cumulative average is required); overall scholarly standing; number of international relations courses taken; activities on the campus related to appreciation of international relations by the Lehigh community; and the contribution to university life.

The Philip Francis du Pont Memorial Prize in Electrical Engineering. The Philip F. du Pont Memorial Prize Fund was established in 1929 by L.S. Horner, 1898. The annual income of this fund is awarded each year in the way of prizes, two-thirds to the highest-ranking senior and one-third to the second highest-ranking senior in electrical engineering.

Jonathan B. Elkus Freshman Music Cup. This is awarded each year to a full-time freshman on the basis of membership in marching and concert band, over-all music ability, demonstrated leadership, and exceptional psyche.

Fraternity Alumni Advisory Council Scholarship Improvement Award. This trophy is awarded to the fraternity chapter whose scholastic average for the year is most improved over the average for the previous year.

Joseph C. Gabuzda Jr. Memorial Award. To a deserving junior in electrical or computer engineering who has shown outstanding promise intellectually and in leadership qualities.

Gipson Institute Undergraduate Essay Prize. This prize of $200 is awarded for the best undergraduate paper dealing with an 18th century topic.

The Gold-Hansen Trophy. Provided by Stephen R. Gold, '60, and Robert A. Hansen, '60, the trophy is awarded to a student of at least four semesters' standing with the band who has shown outstanding merit in other ways than musical or marching performance.

Malcolm J. Gordon, Jr., Physics Prize. An annual award is made to the highest ranking sophomore physics major, with some extracurricular activity.

The Bill Hardy Memorial Prize. An annual award is given by Mr. and Mrs. D. Edson Hardy in memory of their son. The recipient is the junior who most nearly reflects the qualities that typified Bill Hardy, who was outstanding in many activities, academic and otherwise.

George D. Harmon Memorial Award. An annual award to an outstanding senior in the history department.

Haskins and Sells Foundation Award. An annual award of $500 is awarded to that accounting student in the College of Business and Economics or the College of Arts and Science who after three years has demonstrated excellence in scholarship, professional potential, extracurricular activities, and moral character.

David Hellekjaer Memorial Award. The friends of Dave Hellekjaer, '80 (1958-1980), created an award in his memory. It is presented annually to a senior who best exemplifies his characteristics, viz: vigorous participation in sports, dedicated commitment to the study of the natural or physical sciences (biology, geology, environment science, physics or chemistry), and loyalty and contribution to a fraternity or sorority.

Joseph C. Hendrzak Memorial Award. The award is made to an outstanding senior student in military science.

Donnel Foster Hewett Award. This is awarded to the senior in geology or geological sciences who has demonstrated the greatest potential for a professional career in the earth sciences.

The Harold J. Horn Prize. The heirs of Harold J. Horn, 1898, established a fund, the income of which is used in the award of a first and second prize, for the two highest ranking juniors in electrical engineering.

Mary O. Hurley Women's Athletic Award. To a woman undergraduate who demonstrates sportsmanship, a cooperative attitude, and an enjoyment of sports with her fellow students.

Kappa Alpha Glee Club Senior Cup. The cup is awarded to a senior for outstanding service to the Glee Club.

The Andrew Wilson Knect III Memorial Award. This award is made each year to the member of the mechanical engineering class graduating in May or June who has exhibited the greatest potential for applying technical training to practical application. The award is an engraved, designed medallion.

Kodak Scholar Awards. These awards are made to second-semester freshmen each year who plan to major in engineering fields other than civil engineering. They cover 75 percent of tuition costs.

Arnie Lasser Award. This award is made to an outstanding undergraduate athlete in football or wrestling from the New York metropolitan area, regardless of need.

Joseph A. Maurer Classics Prize. To a graduating senior majoring in classics who has demonstrated excellence in studying the Latin and Greek languages.

Merck Index Award. A copy of the Merck Index is awarded by Merck and Co., Inc., to a senior in chemistry who is an outstanding student; who has been active in student society affairs; and who has promise of a successful career in chemistry in the judgment of the faculty of the chemistry department.

J. Robert Mumford Award. To the geology senior who has shown the greatest improvement in overall performance.

The Elizabeth Major Nevius Award. Established by Walter I. Nevius, '12, "in loving memory of his wife, who profoundly admired young men of diligence, intelligence, agressiveness and sterling character," the award of $500 is made annually to individuals who have entered their fifth year of work at Lehigh (whether it be a second undergraduate degree or a graduate degree after a first undergraduate degree). The winners are determined by the Committee on Undergraduate Awards and Prizes upon the basis of leadership, citizenship and scholarship.

Class of 1904 Award. The award is presented to an outstanding member of the junior class on the basis of character, scholarship, qualifications indicating promise of future leadership, and extracurricular activities.

C.J. Osborn Award in Metallurgy and Materials Engineering. To a senior in the department of metallurgy and materials engineering who is deemed worthy of recognition by the faculty of the department.

Pat Pazzetti Award. In honor of Vincent J. "Pat" Pazzetti, Jr., '15, to a Lehigh football player of outstanding ability.

The Pennsylvania Institute of Certified Public Accountants Prize. The plaque goes to the senior in the College of Business and Economics majoring in accounting who is outstanding in academic achievement and leadership.

Phi Sigma Kappa Scholarship Cup. This scholarship cup, awarded to the fraternity in the Interfraternity Council having the highest scholastic average for the preceding year, becomes the permanent property of the fraternity winning it for three successive years. The original cup was provided by an alumnus of the Nu Chapter of Phi Sigma Kappa in 1923. Cups are provided by the local chapter.

Leonard P. Pool Memorial Award. This award is made annually to a junior or senior student exhibiting entrepreneurial talents. The late Mr. Pool was chairman of Air Products and Chemicals, Inc.

The Allen S. Quier Prize in Metallurgy. An annual prize has been provided by the daughters of the late Allen S.

Quier in memory of their father, to be awarded to the senior who is adjudged by the staff of metallurgy and materials engineering to have made the most progress in that curriculum. While high scholastic standing is a requisite, the prize is awarded on the basis of progressive achievement in scholastic work, rather than an average rating.

Bosey Reiter Leadership Cup. This award is given to the student whose leadership contributes primarily to the best interests of the university. Leadership is defined chiefly as moral character and combines intellectual ability and common sense. High scholarship and athletic achievements are included as cases of leadership, but neither is necessary or sufficient alone.

Robert Ridgway Senior Prize. This prize is awarded to the senior in the College of Engineering and Physical Sciences with the highest cumulative average.

Col. Edward W. Rosenbaum Award. The award, in honor of Robert Rosenbaum, '17, is awarded each year to recognize the outstanding senior aerospace studies student.

Margaret B. Savic Tennis Award. To the most valuable player on the tennis team.

Scott Paper Company Foundation for Leadership Award. This award is made each year to a sophomore student who must have achieved a high level of scholarship and noteworthy success in extracurricular activities and, in addition, should possess a balance of desirable personal qualities such as intelligence, integrity, strong moral character, loyalty, enthusiasm, physical vigor, persuasiveness and social consciousness. Great weight is to be given to characteristics and abilities that should best equip the individual to succeed as a leader in industrial or commercial activities.

The Senior Band Plaque. The plaque was established by the seniors on the executive committee of the Lehigh University Band to honor a member or members of the senior class of the band who have given outstanding performances in both marching and concert seasons for four years and who have not served in a major administrative capacity in the band.

T. Edgar Shields Band Cup. This is awarded annually to the student who has made the greatest musical contribution to the band.

T. Edgar Shields Glee Club Cup. This is awarded annually to the student who made the greatest musical contribution to the Glee Club.

Sigma Xi Undergraduate Research Award. An award of $50 and associate membership in the society is made to an undergraduate student by the chapter executive committee from departmental nominations. The basis of the award is research potential and demonstrated achievement in research.

Spillman and Farmer Architectural Award. An architectural book and $15 is awarded to the student(s) creating the outstanding architectural or environmental design in the architecture classes of the department of art and architecture.

Alan H. Stenning Award. A prize is awarded each year to a senior mechanical engineering or mechanics student for excellence in an undergraduate engineering project.

Bradley Stoughton Student Award. This award is given to an outstanding senior in the metallurgy and materials engineering department. It consists of a certificate and $50.

Thornburg Mathematics Prize. This prize is made possible through a bequest by the late W.P. Tunstall, '03, in honor of the late Professor Charles L. Thornburg. The prize, consisting of a credit slip to purchase books in the field of mathematics or allied disciplines at the bookstore, is awarded to the senior with the most outstanding record in advanced course in mathematics.

Trustees' Scholarship Cup. The trustees have provided this cup, which is awarded for one year to the living group having the highest scholarship average for the preceding year. The cup becomes the permanent property of any living group winning it for three consecutive years.

Harry M. Ullmann Chemistry Prize. To the highest-ranking seniors in chemistry and chemical engineering.

Undergraduate Merit Award(s) of the Lehigh University Alumni Association. To seniors who by exemplary character, personality, scholarship, and participation in extracurricular activities represent(s) the highest traditions of Lehigh University.

University Service Award. This award is given annually to the senior who has been adjudged to have contributed most during his or her career at Lehigh to promote student body unity, campus cooperation for worthy objectives, and loyalty to the alma mater. It is expected that the student selected shall be of sound character and satisfactory scholarship.

John R. Wagner Award. This is awarded each year to the junior student in mechanical engineering whose scholastic record is the highest in his or her class in the freshman and sophomore years and whose character and life purposes are deemed deserving and worthy.

Wall Street Journal Award. This is awarded each year to a senior finance major primarily on the basis of scholarship.

William Whigham, Jr., Memorial Prize. This is awarded annually to the top-ranking freshman in engineering, based on a cumulative average of the first two semesters.

The Elisha P. Wilbur Prizes. A fund was established by the late E.P. Wilbur, trustee from 1872 until 1910, for distribution in prizes as the faculty might determine. The income from this fund is used to provide two awards, as follows:

Wilbur Mathematics Prizes. A first and second prize to be awarded annually to the two highest-ranking freshman engineers in mathematics, as recommended by the department of mathematics.

Wilbur Scholarship Prize. This prize is awarded annually to the sophomore with the best semester average for the sophomore year.

The Williams Prize in Creative Writing. A prize is awarded annually to the author of a meritorious short story, play, or poem submitted by a Lehigh undergraduate.

The Williams Prize in Dramatics. A prize is awarded annually to a Lehigh undergraduate whose interpretation of a role in production is judged the most outstanding.

The Williams Prizes in English. The late Professor Edward H. Williams, Jr., Class of 1875, established prizes for excellence in English composition and public speaking. The prizes are awarded by the faculty on the recommendation of the department of English, as follows:
Freshman Composition Prizes. A first prize, a second prize, and a third prize are awarded for the three best compositions submitted by freshmen as required work in their English courses.
Sophomore Composition Prizes. A first prize, a second prize, and a third prize are awarded for the three best compositions submitted by sophomores as required work in their English courses.
Junior Composition Prizes. A first prize, a second prize, and a third prize are awarded for the three best essays submitted by juniors as part of the required work in their courses in English.

The Williams Prize in Interpretive Reporting. A prize is awarded annually to a Lehigh undergraduate for meritorious reporting, published or unpublished, intended to interpret the meaning of events or developments that are significant in the life of the university.

The Williams Senior Prizes. These prizes are awarded by the faculty on the recommendation of the committee on Williams Prizes.
First, second, and third prizes are awarded annually to each

of the five fields of economics, English, philosophy, psychology, and history and government for dissertations submitted by regular members of the senior class on or before April 15. The committee on Williams Prizes publishes, before the close of the academic year, a list of recommended subjects for dissertations; but a senior may submit a dissertation upon any other subject in the respective field if the subject has received the approval of the committee.

Each senior entering the competition submits to the committee his or her choice of subject and plan of work by November 15. The awards are made by the faculty upon recommendation of the committee, but no award is made if in any case a dissertation does not meet the standards of merit established by the committee. This standard includes such points as excellence in thought, plan, development, argument, and composition.

The Theodore B. Wood Prize. A prize is awarded under the terms of the will of the late Theodore Wood to the mechanical engineering student who has made the greatest scholastic improvement during the first two years of the college course.

Prizes Awarded by Student Organizations

Alpha Epsilon Delta Award. Alpha Epsilon Delta places the name of the premedical biology freshman with the highest cumulative average on a plaque in the department of biology.

Alpha Kappa Psi Key. The Alpha Sigma Chapter of Alpha Kappa Psi, a professional fraternity in commerce, awards annually the Alpha Kappa Psi scholarship key to the senior pursuing a degree in the College of Business and Economics who has attained the highest scholastic average for three years of collegiate work at Lehigh.

The Alpha Pi Mu Prize. The Alpha Pi Mu honorary fraternity in industrial engineering awards each year an industrial engineers' handbook to a high-ranking sophomore with demonstrated interest in the industrial engineering curriculum.

American Chemical Society Award. The Lehigh Valley section of the American Chemical Society awards a membership in the society and a subscription to a journal of this society to the highest-ranking junior in chemistry or chemical engineering.

American Society of Civil Engineers Prize. The Lehigh Valley Section of the American Society of Civil Engineers offers a prize of a junior membership in the society to the outstanding senior in civil engineering holding membership in the student chapter.

American Society of Mechanical Engineers Associate Membership Prize. The Anthracite-Lehigh Valley Section of the American Society of Mechanical Engineers awards to an outstanding member of the Lehigh University Student Section ASME an associate membership for one year in the parent society.

Alpha A. Diefenderfer Award. In recognition of the late Professor A.A. Diefenderfer's long service as faculty adviser to the organization, the Lehigh University Chemical Society established this award for the highest ranking junior in analytical chemistry.

Eta Kappa Nu Prize. The honorary fraternity in electrical engineering awards a handbook in electrical engineering to the highest-ranking freshman in electrical and computer engineering.

Pi Lambda Phi Journalism Award. This is awarded to an undergraduate for outstanding editorial or business achievement in the field of publications. The trophies are made available by the local chapter of Pi Lambda Phi social fraternity.

Pi Tau Sigma Prize. The honorary fraternity in mechanical engineering awards each year a mechanical engineers' handbook to the highest-ranking sophomore in mechanical engineering.

William H. Schempf Award. This award is made annually to the freshman who has shown outstanding ability and interest beyond the requirements of a normal freshman bandsman. It is made in honor of a former head of the music department by the Beta Sigma chapter of Theta Chi social fraternity.

John S. Steckbeck Award. This award is presented annually to the most outstanding woman freshman athlete in good academic standing. It honors the memory of its namesake, who was director of intramurals. He died in 1979.

Tau Beta Pi Prize. The honorary engineering fraternity awards each year a slide rule or other prize of equivalent value to the engineering sophomore having the highest scholastic average.

VIII

University Academic Calendar

The university academic calendar has evolved over the years to reflect the desires of students and faculty and the needs of the university as a whole.

Generally speaking, classes are scheduled only Monday through Friday. Typically, a three-credit-hour course is offered with either three fifty-minute class sessions Monday, Wednesday, and Friday morning, or with two seventy-five minute classes on Tuesday and Thursday morning. Afternoon classes Monday through Friday are scheduled in either fifty-minute or seventy-five minute segments.

Students should note that the fall semester concludes prior to the holiday vacation in December. To make this possible, classes commence at the end of August. In the spring semester, classes begin following the semester break, and conclude in mid-May.

While every effort has been made to include correct dates in the calendar that follows, the faculty or the University Forum may exercise their right to make subsequent changes.

Spring, 1983

JANUARY

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

FEBRUARY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

MARCH

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

APRIL

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

MAY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

JUNE

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

January 11-17 (Tuesday to Monday)—Graduate registration for the spring semester

January 18 (Tuesday)—Undergraduate registration for the spring semester

January 19 (Wednesday)—Spring semester instruction begins

February 1 (Tuesday)—Last day on which registration for spring courses is permitted

February 22 (Tuesday)—Four o'clock quizzes

February 23 (Wednesday)—Four o'clock quizzes

February 23 (Wednesday)—Friday classes meet

February 23 (Wednesday)—10 P.M.—Spring vacation begins

February 28 (Monday)—8:10 A.M.—Classes resume

March 1 (Tuesday)—Four o'clock quizzes; last day for filing application for degrees in May

March 3 (Thursday)—Four o'clock quizzes

March 14 (Monday)—Midsemester reports due

March 24 (Thursday)—Last day to withdraw from courses with a W

March 26 (Saturday)—1:10 P.M.—Spring vacation begins

April 4 (Monday)—8:10 A.M.—Spring vacation ends

April 4-8 (Monday to Friday)—Preregistration

April 6 (Wednesday)—Four o'clock quizzes

April 7 (Thursday)—Four o'clock quizzes

April 12 (Tuesday)—Four o'clock quizzes

April 13 (Wednesday)—Four o'clock quizzes

April 14 (Thursday)—Last day for May doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts

May 5 (Thursday)—Last day of classes in the spring semester

May 6-9 (Friday to Monday)—Review-consultation-study (RCS) period

May 10 (Tuesday)—Course examinations begin

May 13 (Friday)—Last day for May candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses; last day for October doctoral candidates to arrange for final examinations

May 20 (Friday)—Last day for May doctoral candidates to complete all degree requirements

May 21 (Saturday)—Course examinations end

June 5 (Sunday)—University Day (commencement)

Fall 1983

August 22-27 (Monday to Saturday)—Graduate registration
August 26-28 (Friday to Sunday)—Freshman orientation
August 26 (Friday)—Last day for October doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts
August 29-30 (Monday to Tuesday)—Undergraduate registration for the fall semester
August 31 (Wednesday)—Fall semester instruction begins
September 1 (Thursday)—Last day for filing applications for degrees to be conferred on Founder's Day
September 5 (Monday)—Holiday
September 7 (Wednesday)—Monday classes meet
September 12 (Monday)—First faculty meeting of the academic year
September 14 (Wednesday)—Last day on which registration for fall courses will be permitted
September 16 (Friday)—Last day for October candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses
September 23 (Friday)—Last day for October doctoral candidates to complete all degree requirements
October 3-5 (Monday to Wednesday)—Engineering inspection trips
October 5 (Wednesday)—Four o'clock quizzes
October 6 (Thursday)—Four o'clock quizzes
October 9 (Sunday)—Founder's Day (fall graduation)
October 11 (Tuesday)—Four o'clock quizzes
October 12 (Wednesday)—Four o'clock quizzes
October 13 (Thursday)—Friday classes meet
October 14 (Friday)—Vacation
October 24 (Monday)—Midsemester reports due
October 31 (Monday)—Preregistration begins
November 3 (Thursday)—Last day to withdraw from courses with a W
November 4 (Friday)—Preregistration ends
November 9 (Wednesday)—Four o'clock quizzes
November 10 (Thursday)—Four o'clock quizzes
November 15 (Tuesday)—Four o'clock quizzes
November 17 (Thursday)—Four o'clock quizzes
November 21 (Monday)—Last day for January doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts
November 23 (Wednesday) 10 P.M.—Thanksgiving vacation begins
November 28 (Monday) 7:45 A.M.—Thanksgiving vacation ends; Thursday classes meet
December 1 (Thursday)—Last day for filing applications for degrees to be conferred in January
December 9 (Friday)—Last day for January candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses
December 12 (Monday)—Last day of fall semester classes
December 13-14 (Tuesday to Wednesday)—Review-consultation-study period
December 15 (Thursday)—Course examinations begin
December 16 (Friday)—Last day for January doctoral candidates to complete all degree requirements
December 23 (Friday)—Course examinations end

AUGUST

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

SEPTEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

OCTOBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

NOVEMBER

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

DECEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Spring 1984

January 9-14 (Monday to Saturday)—Graduate registration for the spring semester
January 16-17 (Monday to Tuesday)—Undergraduate registration for the spring semester
January 18 (Wednesday)—Spring semester instruction begins
January 31 (Tuesday)—Last day on which registration for spring courses is permitted
February 21 (Tuesday)—Four o'clock quizzes
February 23 (Thursday)—Four o'clock quizzes
February 28 (Tuesday)—Four o'clock quizzes
February 29 (Wednesday)—Four o'clock quizzes
March 1 (Thursday)—Last day for filing applications for degrees in June
March 10 (Saturday) 12 noon—Spring vacation begins
March 12 (Monday)—Midsemester reports due
March 19 (Monday) 8:10 A.M.—Classes resume
March 27 (Tuesday)—Last day to withdraw from courses with a W
March 29 (Thursday)—Four o'clock quizzes
April 2-6 (Monday to Friday)—Preregistration
April 3 (Tuesday)—Four o'clock quizzes
April 4 (Wednesday)—Four o'clock quizzes
April 5 (Thursday)—Four o'clock quizzes
April 14 (Saturday) 12 noon—Easter vacation begins
April 19 (Thursday)—Last day for June doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts
April 23 (Monday) 8:10 A.M.—Classes resume
May 8 (Tuesday)—Last day of classes in the spring semester
May 9-10 (Wednesday to Thursday)—Review-consultation-study (RCS) period
May 11 (Friday)—Course examinations begin; last day for June candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses; last day for October doctoral candidates to arrange for final examinations
May 18 (Friday)—Last day for June doctoral candidates to complete all degree requirements
May 23 (Wednesday)—Course examinations end
June 3 (Sunday)—University Day (commencement)

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29			

MARCH

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

MAY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Fall 1984

August 20-25 (Monday to Saturday)—Graduate registration
August 24-26 (Friday to Sunday)—Freshman orientation
August 27-28 (Monday to Tuesday)—Undergraduate registration for the fall semester
August 29 (Wednesday)—Fall semester instruction begins
August 31 (Friday)—Last day for October doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts
September 3 (Monday)—Holiday
September 4 (Tuesday)—Last day for filing applications for degrees to be conferred on Founder's Day
September 5 (Wednesday)—Monday classes meet
September 10 (Monday)—First faculty meeting
September 12 (Wednesday)—Last day on which registration for fall courses will be permitted
September 14 (Friday)—Last day for October candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses.
September 21 (Friday)—Last day for October doctoral candidates to complete all degree requirements
October 1-3 (Monday to Wednesday)—Engineering inspection trips
October 2 (Tuesday)—Four o'clock quizzes
October 3 (Wednesday)—Four o'clock quizzes
October 4 (Thursday)—Friday classes meet
October 5 (Friday)—Vacation
October 10 (Wednesday)—Four o'clock quizzes
October 11 (Thursday)—Four o'clock quizzes
October 14 (Sunday)—Founder's Day (fall graduation)
October 22 (Monday)—Midsemester reports due
October 29-November 2 (Monday to Friday)—Preregistration for the spring semester
November 1 (Thursday)—Last day to withdraw from courses with a W
November 6 (Tuesday)—Four o'clock quizzes
November 8 (Thursday)—Four o'clock quizzes
November 13 (Tuesday)—Four o'clock quizzes
November 14 (Wednesday)—Four o'clock quizzes
November 19 (Monday)—Last day for January doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts
November 21 (Wednesday) 10 P.M.—Thanksgiving vacation begins
November 26 (Monday) 7:45 A.M.—Classes resume; Thursday classes meet
December 3 (Monday)—Last day for filing applications for degrees to be conferred in January
December 7 (Friday)—Last day for January candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses
December 10 (Monday)—Last day of fall semester classes
December 11-12 (Tuesday to Wednesday)—Review-consultation-study (RCS)
December 13 (Thursday)—Course examinations begin
December 14 (Friday)—Last day for January doctoral candidates to complete all degree requirements
December 22 (Saturday) 10 P.M.—Course examinations end

AUGUST

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

SEPTEMBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Spring 1985

January 7-12 (Monday to Saturday)—Graduate registration for the spring semester
January 14-15 (Monday to Tuesday)—Undergraduate registration for the spring semester
January 16 (Wednesday)—Spring semester instruction begins
January 29 (Tuesday)—Last day on which registration for spring courses will be permitted
February 13 (Wednesday)—Monday classes meet
February 14 (Thursday)—Friday classes meet
February 15-18 (Friday to Monday)—Vacation
February 20 (Wednesday)—Four o'clock quizzes
February 21 (Thursday)—Four o'clock quizzes
February 26 (Tuesday)—Four o'clock quizzes
February 27 (Wednesday)—Four o'clock quizzes
March 9 (Saturday) 12 noon—Spring vacation begins
March 11 (Monday)—Midsemester reports due
March 18 (Monday) 8:10 A.M.—Classes resume
March 25-29 (Monday to Friday)—Preregistration for fall semester
March 28 (Thursday)—Last day to withdraw from courses with a W
April 2 (Tuesday)—Four o'clock quizzes
April 3 (Wednesday) 10 P.M.—Easter vacation begins
April 9 (Tuesday) 7:45 A.M.—Classes resume; Thursday classes meet; four o'clock quizzes
April 10 (Wednesday)—Four o'clock quizzes
April 11 (Thursday)—Four o'clock quizzes
April 19 (Friday)—Last day for June doctoral candidates to deliver to the dean of the Graduate School approved dissertation drafts
May 7 (Tuesday)—Last day of classes in the spring semester
May 8-9 (Wednesday to Thursday)—Review-consultation-study period
May 10 (Friday)—Course examinations begin; last day for June candidates for master's degrees to deposit with the dean of the Graduate School unbound copies of their theses; last day for October doctoral candidates to arrange for final examinations
May 17 (Friday)—Last day for June doctoral candidates to complete all degree requirements
May 22 (Wednesday)—Course examinations end
June 2 (Sunday)—University Day (commencement)

JANUARY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

FEBRUARY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

MARCH

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

APRIL

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MAY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

JUNE

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

IX

The Index: Where to Find What You Need to Know









A volume such as this is necessarily a compilation of information serving many people in many ways. The reader may find it useful to peruse the edition in its entirety, thereby possibly locating information that could become helpful in planning the university career. Those desiring information on specific subject areas may find this index helpful; however, the index does not purport to refer readers to every subject covered in the catalog.

Lehigh University has been designated as home base for the North East Tier Ben Franklin Consortium and Technology Center. A description appears on page 48.

Major Subjects

The university offers the following major subjects. (Minor programs in three subject areas also are listed.)

Lehigh
(USPS 309-580)

Second-class postage paid at
Bethlehem, Pennsylvania 18015